Slash Pine

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SLASH PINE is a fast-growing southern pine and yields revenue in turpentine gum at an early age while it is growing timber.

Farmers and other owners of cut-over pinelands in the South Atlantic and Gulf regions are deriving a good profit from poorly drained and other lands by utilizing them for the production of turpentine and timber as well as for the grazing of livestock.

Well-stocked stands of slash pine on average land at ages of 15 to 25 years produce wood for pulpwood, stave blocks, fuel, etc., at the rate of one-half to 1 cord an acre a year, or sawlogs at the rate of 100 to 300 board feet an acre a year. On good-quality land well-stocked stands are growing at the rate of 1 to 2 cords, or 300 to 600 board feet, per acre yearly.

Slash pine can be profitably grown in the South on poor and wet lands, but it grows better on good land.

There are millions of acres of worn-out or unimproved parts of farms and cut-over lands that are profitless for other crops, but suitable for the production of timber and naval stores.

By proper methods of protection and cutting, southern pine forests can be perpetually renewed and kept continuously productive.

Young pine is valuable.

The picture on the title page shows second-growth slash pine in southern Georgia being worked for turpentine.

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SLASH PINE

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SLASH PINE—A DUAL-CROP TREE

SLASH PINE, a native of the South Atlantic and the Gulf region, is one of the most profitable forest trees in the United States.[1] In its own range it is being extensively cared for and planted in orchards because of its rapid growth and high value for the production of naval stores, pulpwood, and lumber.

Second-growth slash pine, following the cutting of the original forest, has spread rapidly over large areas of flatlands and low uplands of the region. It has been particularly aggressive in establishing itself on old fields and other idle or waste lands about farms and towns. A large percentage of the total amount of sap pine cut for all purposes in southern Georgia and northern Florida is slash pine. Timber from original-growth trees is used or sold without discrimination along with longleaf pine.

The wood of slash pine is straight-grained and suitable for a wide variety of uses. The width of the rings naturally depends on the rate of growth. The yield of crude turpentine from slash pine is the largest from any of our native trees. In the economic development now well under way in the South, slash pine is playing a large part in bringing lands not suited for other agricultural crops into their most profitable use.

A caution in managing slash pine lands cannot be too strongly emphasized. The custom of turpentining small trees before they reach the age of profitable working and ample seed production calls for special attention in management. There should in all cases be an

[1] The botanical name is *Pinus caribaea* Morelet. Formerly in forestry literature the tree was called Cuban pine.

> The right use of the turpentine hack and later the ax and saw, and the protection of the land at all times from fire are the keys to the problem of growing slash pine profitably as a crop.

abundance of seed just before making the final cutting of the timber crop so as to provide for the renewal of the stand as the necessary basis for another timber crop on the land.

How can you tell slash from other pines?

Because of the general resemblance of young slash pine to vigorous loblolly pine, and of the mature slash pine to longleaf pine, considerable difficulty is experienced by persons unfamiliar with the southern pine forest in differentiating the species. However, slash pine is not difficult to identify if one possesses the essential information regarding the leaves, cones (burs), bark, and winter bud.

The bark (fig. 1) is fairly similar to that of longleaf pine. It differs from that of loblolly pine by being less deeply furrowed. Old mature slash pine may be readily told by its orange-colored bark plates or scales.

The leaves grow in clusters of two or three, usually with more of the two-leaved clusters. They are mostly 8 to 12 inches long, and bright, glossy rich green (fig. 2). The heavy, shiny green foliage helps greatly in distinguishing slash pine from the associated longleaf pine with its coarser and rather bluish-green foliage. Loblolly pine, like longleaf pine, has three bluish-green leaves in a cluster, but it has much smaller leaves than long leaf or slash.

The cones are egg shaped and average 3 to 4 inches in length and, when closed, are about 2 inches wide (fig. 2). A prickle is borne on the lustrous or varnished brown end of the cone scale.

The terminal bud is large, is reddish brown in color, and in the spring elongates into a straight, stout, light-gray "candle" about as thick as a large pencil. Longleaf pine, in distinction, has a similar but larger bud elongating into a light-gray candle an inch or more in diameter.

The main characteristics by which slash pine may be identified are the two-leaf or three-leaf clusters of long, dark-green leaves; the slender prickle on the cone, pointing straight or slightly curved upward on the lustrous-brown scale of the fresh mature cone; and the early-spring candle or shoot, which is light gray, erect, and about one-half inch in diameter.[2]

Mature trees of slash pine rise to heights of 80 to 125 feet, with clear lengths of 40 to 70 feet. Diameters of trunks range from 2 to 3 feet, measured at breast height, or 4½ feet from the ground.[3] Old-growth trees at maturity are mostly from 100 to 200 years old.

WHERE SLASH PINE GROWS

The natural range of slash pine extends from about Charleston, S. C., westward through the lower parts of Georgia, Alabama, Mississippi, and southeastern Louisiana to the Mississippi River (fig. 3) There are large areas of slash in Georgia and in Florida, where the tree grows nearly to the end of the peninsula. Slash pine is commercially important over its whole range.

In the original forest slash pine was confined mostly to the poorly drained flatlands and borders of swamps and bodies of fresh water. With the subsequent extensive cutting slash pine was released in much

[2] The spring shoot of loblolly is grayish green, slender, and often curved or drooping instead of erect.

[3] Unless otherwise stated, all diameters referred to throughout this bulletin are based on measurements at breast height.

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FIGURE 1.—A young generation of slash trees about 14 years old is shown with a mature tree. Light orange-colored scales or plates of bark serve to distinguish mature slash pines from other species of pines.

the same way as was loblolly pine farther north, and it is now spreading widely over lands formerly dominated by longleaf pine (fig. 4). It is found on many different kinds of land, but not on dry, deep sandy ridges. On wire grass and palmetto flats it is often the only second-growth species of pine. Slash pine thrives extensively over the low, rolling lands of the southern Coastal Plain, in sandy loam soils in poorly drained situations, and in the wet, mucky soils of bays,

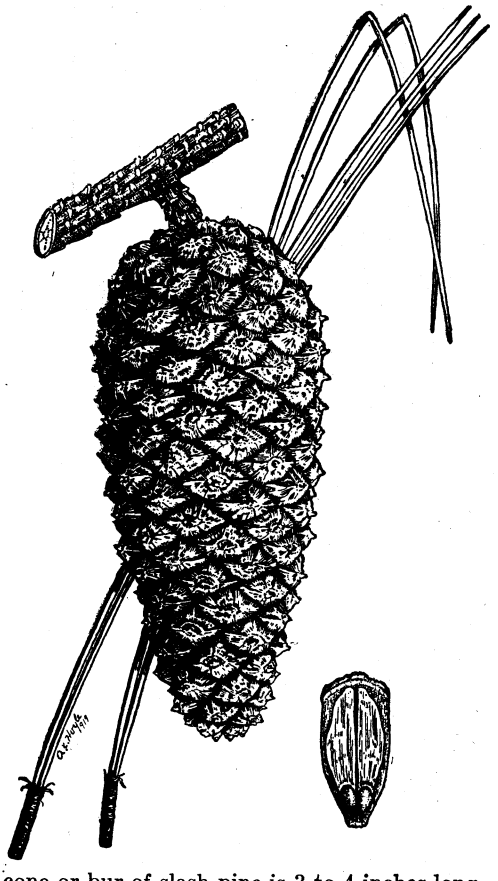

FIGURE 2.—The cone or bur of slash pine is 3 to 4 inches long. The ends of the cone scales are plump, rounded, lustrous, and bear a small prickle. At the base of each scale are borne two seeds, each with an ample wing for wide dispersal. Leaf bundles of slash pine contain either two or three leaves.

ponds, and swamps. It will tolerate a highly acid condition in the surface soil, and a calcareous substratum does not appear to be unfavorable to its growth. On soils with hardpan at shallow depths the tree appears to be somewhat dwarfed in size. It is absent from the very dry, deep sands of the "pine-barren" hills, such as are found in parts of western Florida and southern Mississippi; but even in those sections it is locally abundant on wet flats and close to lakes and streams and in the numerous ponds scattered all over the Coastal Plain. By means of planting the range of slash pine is being considerably extended.

THE WOOD AND ITS USES

Slash pine averages the heaviest, hardest strongest of all the commercial conifer woods in the United States.[4] The weight of the air-

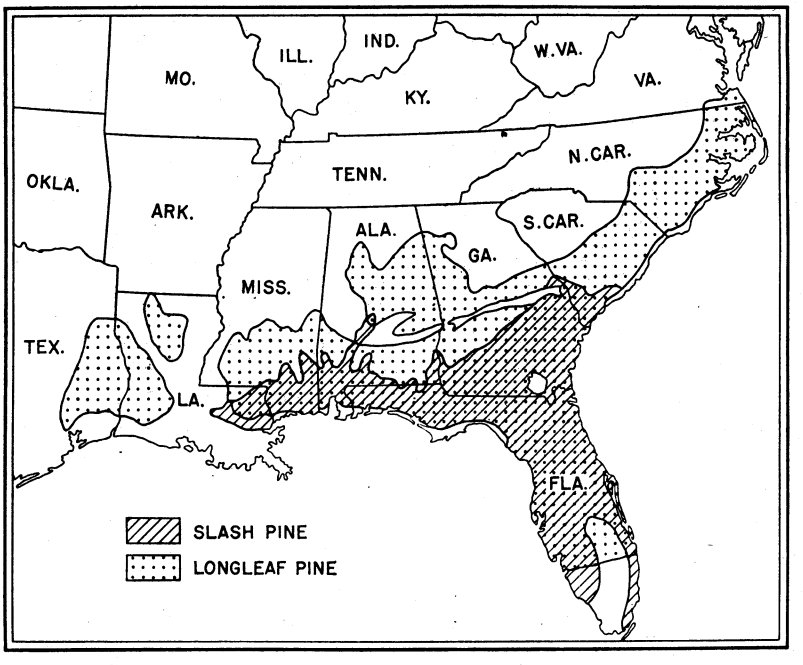

FIGURE 3.—Slash pine is found growing naturally in the region shaded by lines Longleaf pine is found in the region indicated by scattered dots. Both kinds of pine thus occur in the slash pine belt.

dry heartwood averages 45 pounds per cubic foot. In the butt cut the wood averages about 55 percent of dense bands of summerwood, while farther up the tree the proportion of summerwood decreases, at the top of the second cut to about 40 percent (fig. 5).

What are the chief uses of the wood?

The lumber from mature slash pine is used for structural purposes and is in demand for bridges, trestles, docks, warehouses, and factories, in which it is employed for dimension timbers, posts, piles, and joists. On account of its strength and stiffness, it is used for railroad cars, and its hardness and wearing qualities make it suitable for flooring. It is extensively used for veneers for boxes and other packages, and as boards for slash cooperage.

Second-growth or "sap" slash pines after being turpentined are extensively cut for use as cross ties and pulpwood.

The wood of slash pine is well adapted for making paper pulp, and the mills accept it (fig. 6) readily along with that of other kinds of pine. The wood is manufactured into kraft paper, which is the extensively used brown wrapping paper made in various thicknesses

[4] According to results of tests made at the Forest Products Laboratory, U. S. Forest Service, the wood of slash pine averages a little heavier, harder, and stronger than that of longleaf. Dept. of Agr. Tech. Bull. No. 479, Strength and Related Properties of Woods Grown in the United States.

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FIGURE 4.—Thrifty slash pine trees 22 years old. One group of the smaller trees has been worked for turpentine and cut out, leaving the larger trees to grow for other crops of turpentine and poles, piling, or saw timber.

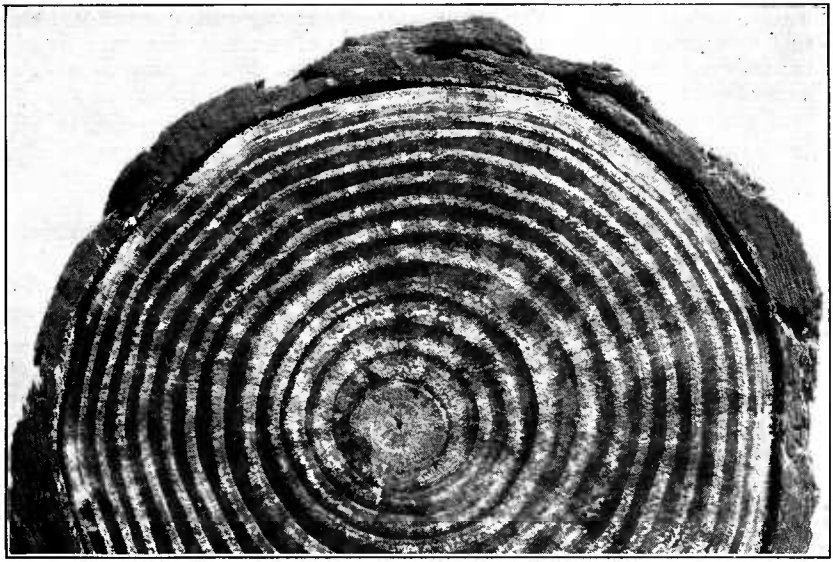

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FIGURE 5.—The very dense or heavy wood of the slash pine, formed even during its early years, is a good characteristic of the tree. The 17-year-old tree shown in the section produced 63 percent dense summerwood, leaving only 37 percent soft springwood.

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FIGURE 6.—The use of southern pine for pulpwood is rapidly increasing. The pulp mills buy round or split wood from 4 to 12 inches in diameter. There is a much larger demand than formerly for slash and other pines for making paper.

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and shades of color. The paper industry is expanding rapidly throughout the pine region of the South. Analysis has shown a low percentage of resin in sapwood of cut trees. Slash pine is also used extensively for fuel. Because slash pine occurs in dense stands of straight clean trees, it is one of the choicest timbers for poles and piling, for which use it is cut in large quantity and brings good prices (fig. 7).

GROWTH OF TREES

Slash pine is one of the most rapid growing and earliest maturing of all our forest trees. Growth in height and in diameter is especially rapid during the younger stages up to about 20 years of age. One-year-old seedlings commonly reach 8 to 12 inches in height.

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FIGURE 7.—Slash pine trees grow in close or dense stands and after turpentining are cut in great numbers for telephone and power-line poles. Treated with creosote they will last for 20 to 40 years.

At 5 years, slash pines range mostly from 8 to 12 feet in height. During the next 5 to 10 years an upward growth of 2 to 3 feet yearly is not uncommon. When about 20 to 25 years of age the rate of upward growth slackens, apparently being about the same as that of longleaf on situations of similar grade. In crowded stands (fig. 8) the increase in diameter is slower than that of trees growing a considerable distance apart. Table 1 shows for different ages the average heights and diameters of slash pine trees and the number of trees per acre found in well-stocked stands. The range in size at any given age varies chiefly with the favorableness of the soil or situation and with the tree density, or number of trees per unit area.

How fast do slash pine trees grow?

For example, as shown in table 1,[5] at 15 years of age the trees in well-spaced stands range in height from 29 up to 48 feet, and in open-grown stands (columns 5, 6, and 7) in diameter from about 5 to more

[5] The tables of growth, volume, and yield of timber and much of the information on good turpentine practices are based upon the results of studies carried on by the Southern Forest Experiment Station of the Forest Service, located at New Orleans, La.

than 8½ inches. If, however, the trees have grown closely with less space for development, it is not uncommon to find them from about 4 to 6½ inches in diameter at breast height, as shown in columns 8, 9,

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FIGURE 8.—The adaptability of slash pine to heavy wet soils enables it to grow rapidly even in dense stands, thus producing a large amount of wood in a relatively short period. This stand should now be thinned for wood products and worked conservatively for turpentine. The latter operation can be continued for 20 to 30 years.

and 10. At 30 years slash pine stands usually consist of trees ranging from 48 to 79 feet in height, and in diameter in open stands from 8 to 13½ inches, or in crowded stands from 6 to 10½ inches. Crowded stands 30 years old may have about 300 trees per acre that measure 7 inches and more in diameter. Open, or better spaced stands for turpentining may have from 150 to 200 trees per acre.

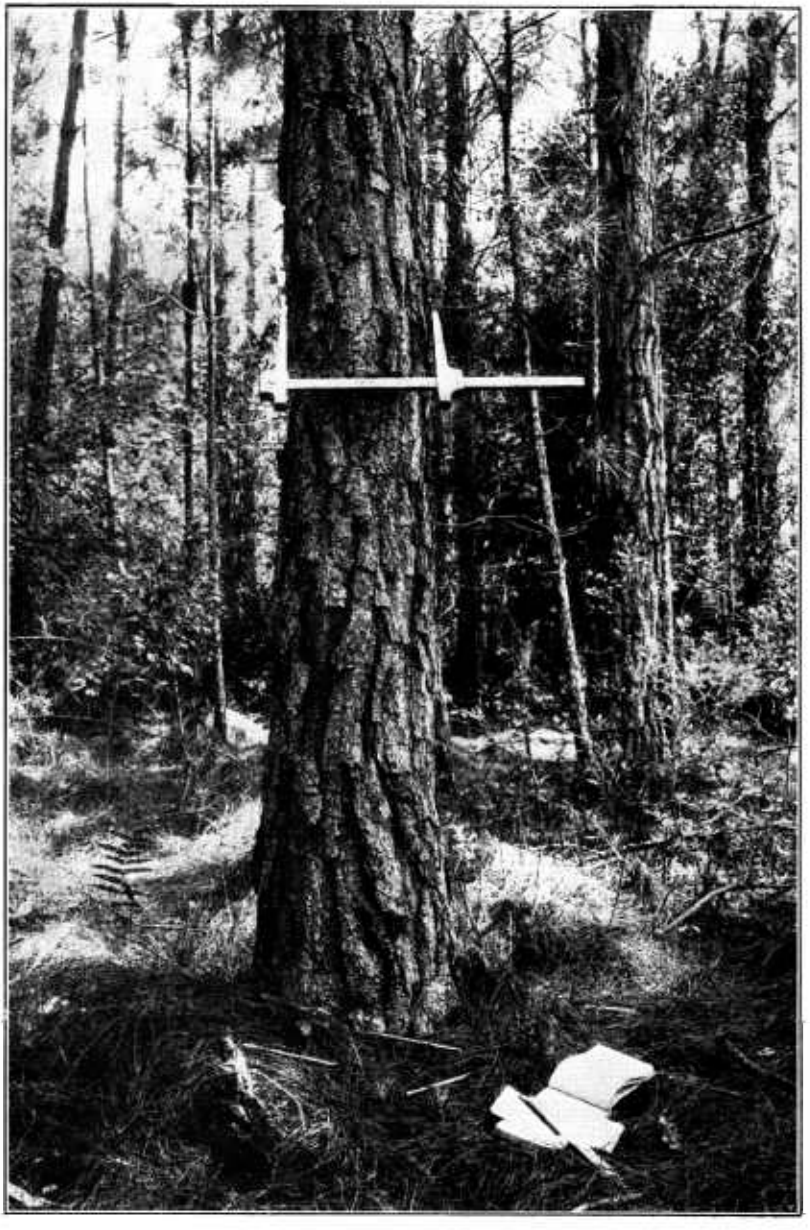

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FIGURE 9.—Example of fastest growth of slash pine resulting from continuous fire protection. The trees in this 17-year-old unburned stand were mostly from 8 to 13 inches in diameter and from 50 to 65 feet tall. The average tree was 10.7 inches in diameter (breast height) and 61 feet tall. In the 17 years this open-grown stand had produced 12,600 board feet of lumber. The thick mat of pine leaves or straw, plainly seen in the picture, affords favorable soil protection against extremes of heat and drought.

TABLE 1.—*Average size of slash pine trees at different ages grown in open and in close stands on different grades of soil; also average number of trees per acre*

Age of trees (years)	Height of trees on—			Diameter of trees (breast height)						Trees per acre in fully stocked timber stands [1]
				Open-grown stands on—			Close-grown stands on—			
	Good land	Average land	Poor land	Good land	Average land	Poor land	Good land	Average land	Poor land	
	Feet	*Feet*	*Feet*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Number*
15	48	39	29	8.8	6.9	5.2	6.6	5.2	3.9	55
20	61	48	36	10.3	8.0	5.9	7.7	6.0	4.4	150
25	71	56	42	12.3	9.6	7.1	9.2	7.2	5.3	265
30	79	63	48	13.7	10.8	7.9	10.5	8.3	6.1	300
35	86	69	52	15.2	12.0	9.0	11.7	9.2	6.9	305
40	92	73	55	16.6	13.1	9.9	12.8	10.1	7.6	295
45	96	77	58	17.1	13.5	10.1	13.7	10.8	8.1	280
50	100	80	60	18.1	14.2	10.7	14.5	11.4	8.6	260
55	103	83	62	18.8	14.8	11.0	15.0	11.8	9.0	245
60	106	85	64	19.4	15.2	11.6	15.5	12.2	9.3	230

[1] All trees 7 inches and over in diameter outside bark at breast height. The trees on the better qualities of land are fewer and larger in diameter; the number on the poorer lands is greater and the trees are smaller in diameter.

The sizes of trees growing in good grade of soil are shown in the columns headed "Good land." The class "Poor land" includes very wet or highly acid soils, on which, however, slash pines often seed freely, but the trees make only slow growth and reach relatively small sizes at maturity. The "Average land" class applies to the great bulk of lands on which slash pine is found growing.

An open stand growing in an old field in northeast Florida is shown in figure 9, where the average tree of the 17-year-old stand was nearly 11 inches in diameter and 61 feet tall. Fire protection had been afforded throughout the life of the stand, which undoubtedly accounts for the large size and thriftiness of the trees and the maximum timber yield of the stand. Such open-grown or orchard-like stands favor the early production of turpentine and merchantable sawlogs, but sacrifice a larger production per acre at a later date. However, moderately open-grown stands should be favored over too-dense stands.

Do tree trunks lengthen?

Yes, but only by new growth at the top. Once the side limbs are formed, or set, they remain in that same position throughout the life of the tree, or until they die and drop off. All limbs or branches from the main trunk reach to the heart or center of the tree.

THINNING PINE STANDS

What effect does thinning have upon growth?

As in a stand of corn or cotton, the trees in a full pine stand crowd upon each other, and the stronger trees gradually crowd out the weaker. Too few trees on an acre result in bushy tops and knotty lumber; too many trees mean a slowing up of individual growth. There is a right number, varying with the age and location, to obtain the best growth of the largest number of trees. Thinnings are made when it is necessary to reduce the number of trees so as to obtain the maximum growth for the kind of product desired.

How should thinnings be made?

There are two ways of thinning pine stands. The whole subject of thinning slash pine stands is closely related to the working of trees for turpentine.

A so-called low thinning, as shown graphically in figure 10, consists of cutting out the smaller, less vigorous, diseased, and unpromising trees. They may be worked first, but only if profitable. This method favors the largest and best trees and more nearly keeps the timber production at its capacity. Size and quality count much in the value of the timber.

A well-known principle is to wait until the trees to be removed have reached a usable size, so that the thinning may at least pay for itself. The material removed may be used for firewood, pulpwood, excelsior wood, or small saw timber. However, in actual practice with relatively cheap labor during slack periods, it is often good practice to thin overcrowded young pines before they reach usable size. An idea of the number of trees per acre in full timber stands at different ages can be obtained from the last column of table 1. For best production of turpentine these numbers should be reduced one-half to two-thirds. Closely related to this subject is the plan of thinning and turpentining found on page 24, which should be considered along with this discussion (fig. 11).

In a so-called high thinning, the larger trees are worked and cut, thus giving space for the smaller trees to expand. It is not an uncommon practice of owners to work and cut the largest trees, because they are the first to become merchantable. What happens then is that the formerly stunted trees recover and attain normal growth. This adjustment usually requires a number of years, during which there is a loss in the growing power of the land. Thinning by this method (of cutting out the largest trees) permits of a periodical money return every 5 years or so, a feature which appeals strongly to the farmer or other owner of timberland and is especially desirable when adapted to cutting timber, without turpentining it, for pulpwood, fuel wood, or other small-sized product.

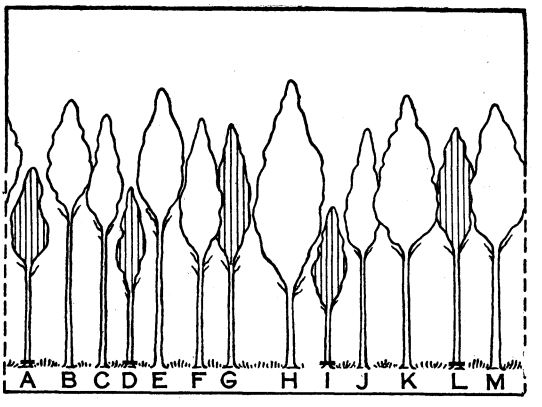
Pruning side branches makes clear trunks, desirable for turpentining and later for poles, piling, and saw timber. It may be started relatively early when the trees are 12 to 15 feet high. A good rule for young trees is to prune the lower half of the trunk and later the lower two-thirds. Too heavy pruning checks the tree's growth. Branches should be cut close to the main trunk in order not to leave a stub and even slightly wound the living layer (cambium) lying between the inner bark and the last layer of wood (fig. 11, *A*). An ordinary curved pruning saw has proved a good tool to use. A short ladder to reach the higher branches is also desirable.

TURPENTINING SLASH PINE

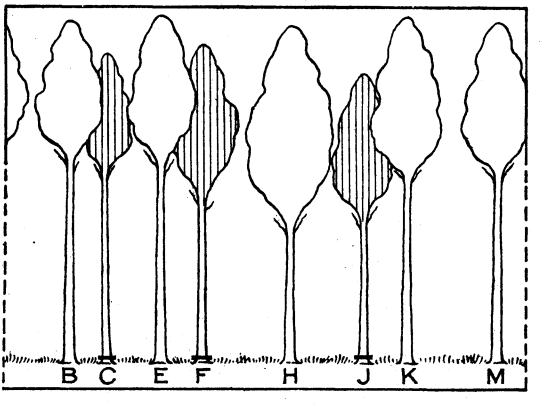
The growing of slash pine as a farm crop or, on a larger scale, as an agricultural industry centers largely about its capacity for producing naval stores as well as sap pine wood.

For every dollar of profit made from the wood of slash pine there is likely to be a return of not less than $2 from the crude gum (oleoresin). A too-common practice has been to work the trees as soon as they reached diameters from 6 to 8 inches, and after 3 to 4 years of working

Thinning.—Age of the trees, 5 to 10 years. A light thinning is to be made by cutting out the smaller, slower-growing trees, *A*, *D*, *G*, *I*, and *L*. This will still keep the bigger trees slightly crowded to force them to grow upward instead of growing outward and becoming bushy.



Thinning.—Age of trees, 15 to 20 years. Another thinning is to be made now of the smaller, less vigorous and less promising trees, *C*, *F*, and *J*.



Final cutting.—Age 30 to 40 years. The final cutting is made of all trees except one, *H*, a vigorous, bushy-topped tree, which is left to produce seed and restock the land. About three such trees are left growing on each acre until the land is well reset with young trees.

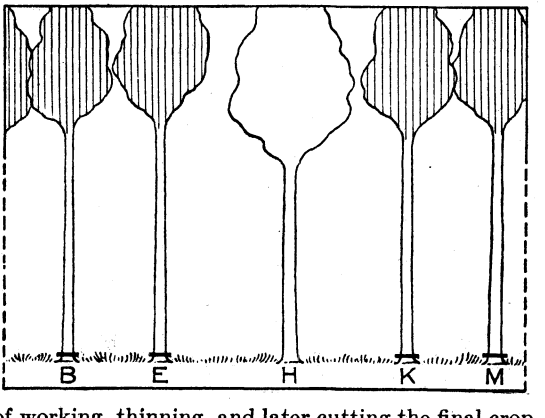


FIGURE 10.—A good method of working, thinning, and later cutting the final crop of pine trees where turpentine and timber products are desired at intervals. The smaller, less vigorous, and defective trees of this even-aged stand are worked and cut out, giving space for the stronger-growing trees to grow. This is repeated a few years later. The cuttings produce fuel wood, cross ties, small sawlogs, or pulpwood. The final cut produces saw timber or piling of good size, grade, and value. The trees to be cut are shaded. The letters aid in identifying the trees.

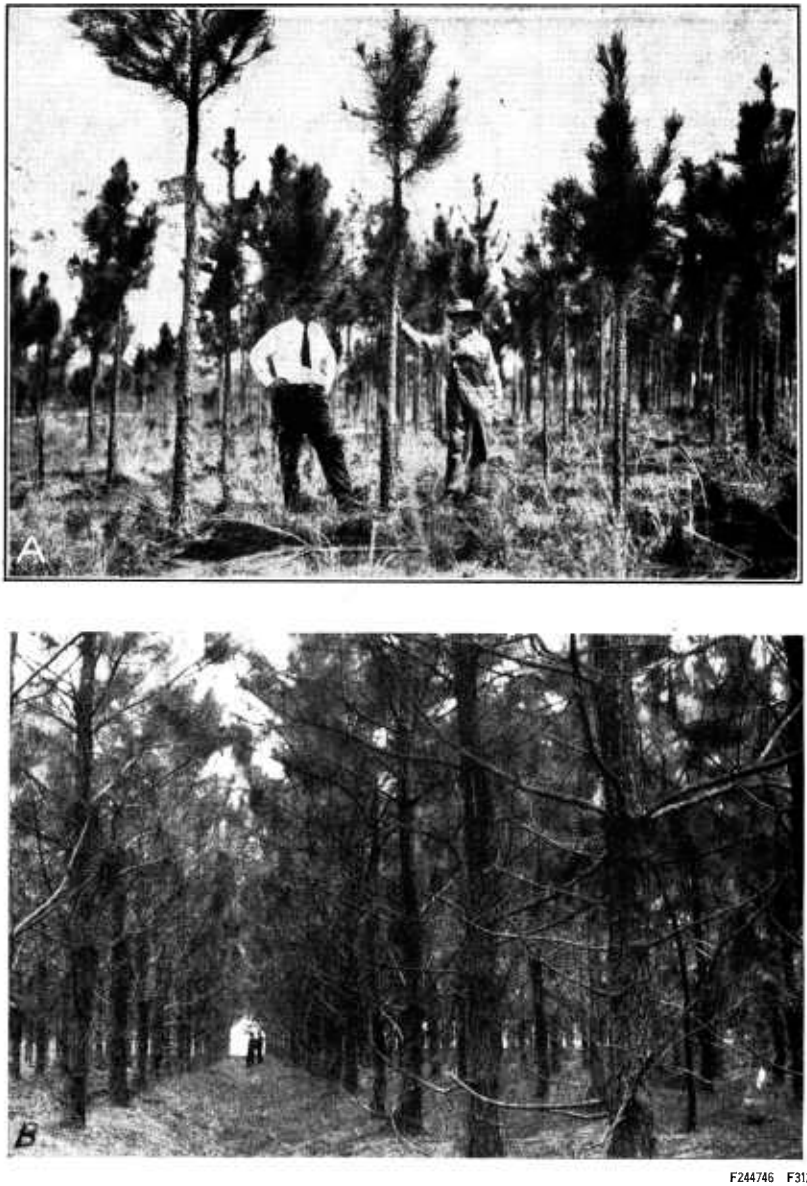


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FIGURE 11.—Thinning and pruning young slash pine are desirable practices, favoring better growth and higher quality and value: *A*, This farmer (on right) during slack time in one winter thinned and pruned 86 acres of dense sapling slash pines. Stands of 900 to 2,000 saplings per acre were cut down to 150 to 300 trees. Both the pruning and thinning were somewhat too heavy, reducing the amount of growth. *B*, A very thrifty planted stand of slash pine 9 years old that should already have had two light prunings. The growth would not have been reduced, and the value of the stand would have been markedly increased.

to abandon the stand. Usually the trees have soon been greatly injured by fire, and in this manner second-growth trees have been extensively destroyed.

With the increase in the value of pine, practices of turpentining are improving. However, much pine timber is still being worked too small and too young, and the chipping is generally too deep and too wide up the tree. In order to keep pace with the keen competition that exists in the naval stores industry the successful turpentine man needs to use methods that will give him the greatest possible gum yields, keep down the costs, and maintain the vigor of his trees.

What are gum and naval stores?

When the sapwood of pine trees is wounded or chipped, it bleeds a thick sticky liquid known as crude gum (oleoresin). The gum is not, as is often supposed, the sap of the tree. It is not drained from a store in the tree but is formed in small cells or ducts scattered in the sapwood. When the tree is cut or wounded, these increase greatly in activity in order to heal over the wound. The heartwood is dead and, if cut, does not produce gum although it contains considerable hard resin.

It is well known in the South that this gum when heated in a still gives off a volatile liquid called spirits of turpentine, leaving a heavier thick residue which, upon cooling, solidifies to form rosin. In the days of wooden ships, turpentine and rosin and other products, known as naval stores, were made and extensively used in calking and waterproofing the hulls as well as in tarring the ropes.

How does slash pine rank in gum production?

Slash pine excels all other native pines in the quantity of gum which flows from the trees when chipped.

Its gum, when freshly exuded, is clear and about the color of light-yellow honey. As compared with longleaf or "hill" yellow pine, its nearest competitor, slash pine yields from its dip and scrape combined a slightly higher percentage of spirits of turpentine and a higher grade of rosin. In contrast to longleaf it produces only a little scrape. It is not uncommon to hear it said that slash pine is more likely to "dry face" and die from turpentining than is its associate, longleaf pine.

What are some good practices in turpentining?

Practices that are generally recognized to be advisable as a means of getting the most revenue out of timber, consistent with conditions of labor and market, include the following:

(1) Work no trees under 9 inches in diameter (at breast height measured outside the bark). Trees to be removed in thinning or improvement cutting may be considered as exceptions to this rule. The size of such trees that can be worked at a profit depends on the vigor or rate of growth and the density of the trees.

Only small yields, with rarely any profit, are obtained from trees less than 9 inches in diameter. Beginning with a 9-inch tree and working one low face at a time insures a high, sustained yield over a period of years and the largest profit in the long run to both owner and operator (fig. 12).

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Undersized trees in planted stands can often be worked profitably previous to thinning.

(2) Work only one face on trees from 9 to 14 inches in diameter, and never more than two faces at the same time on any tree.

(3) Advance streaks should be made preferably 4 to 6 weeks ahead of the regular chipping season.

(4) Use rust-free cups and gutters. Aprons or gutters should be attached with large-headed rustproof tacks, or they should be inserted in very light ax cuts. Do not slab off unnecessary amounts of bark and wood at the base of the tree. Careful hanging of cups and aprons or gutters prevents waste of gum.

(5) Use a No. 0 hack, as this permits cutting streaks one-half inch up the tree and three-fourths inch deep; this is known as medium-

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FIGURE 12.—Good turpentining is shown. Only the larger trees, 10 inches in diameter or over, are being worked, with only one face per tree, and in 2 years the faces are only 32 inches in height. The cups were raised for the second year's working.

light chipping. Conservative methods of turpentining give a longer working life to the trees than heavy workings, which cause dry face and destroy more timber.

Low chipping, faces one-fourth to one-half inch in width, gives more gum than high (three-fourths inch) chipping over the lifetime of the tree. However, chipping one-half inch in height is best if the face is to be worked for 2 to 4 years or more. Low chipping is adapted for owners wishing to operate their timber continuously over a long period of years.

In practice depth of chipping ranges mostly from one-fourth to three-fourths of an inch (fig. 13). The yield of gum at the time increases considerably with an increase in the depth of chipping. Fast-growing slash pine can be chipped three-fourths of an inch deep for 4 or 5 years. Deep chipping in slow-growing timber results in exces-

sive dry face. Also deep chipping weakens the tree mechanically, making it more likely to be windthrown.

(6) Hang the cups as low as possible when the trees are first worked to prolong the working life of faces.

(7) Chip not more than one-third the circumference of the tree for a single face.

(8) Leave at least 4 inches of living wood for bars between the faces on all trees.

FIGURE 13.—Cupping trees for gum: *A*, Chipping a streak on a face is good turpentining practice. The cup is hung low, the tins are inserted lightly, and the streaks are shallow. *B*, Veteran slash pine tree which has been worked for more than a quarter century, first by the old boxing method on the front and the back faces. These have nearly grown over, and now active turpentining is under way on the new wood.

(9) If the crop is not well protected from fire, following the season's working, rake the ground clean for a distance of 2½ feet on all sides from the base of each worked tree (fig. 14).

More and more working is being done under fire protection on rough land. This eliminates the expense of raking and burning.

What are some bad turpentining practices?

Unprofitable practices of working timber include: (1) Working too small trees (figs. 15 and 16), (2) chipping too deeply and too wide, (3) placing too many faces on trees, and (4) leaving insufficient width in bars between faces.

It is difficult for private owners and operators to break away from the custom of cupping very small trees and over cupping large ones. In their desire for immediate returns they sacrifice heavily in income, or "kill the goose that lays the golden egg." A case is known in which

slash pine trees were cupped when 8 years old and the same trees backcupped 7 years later. Frequently all trees are cupped down to 6 or 7 inches in diameter, 2 cups hung on trees down to 9 or 10 inches, and 3 cups hung on trees 13 inches and over by laborers who are paid on the basis of each 1,000 cups hung, or of each crop of 10,000 cups. Heavy working is wasteful practice, except for the purpose of clearing up land or thinning heavy stands.

The flow of gum appears to be generally in proportion to the size and vigor of the trees and the size of the face up to the point where the tree is faced too severely. Practical men in the turpentine industry repeatedly express the opinion that a large percentage of the smaller-sized trees now bled are too small to pay for the cost of operation. The almost complete loss by wind and fire of small trees during or after severe turpentine operations is another important economic reason for adopting conservative methods.

F210492

FIGURE 14.—If the crop is in much danger of burning, at the close of the season each tree is raked in order to give protection. Unburned land makes thriftier trees which yield more gum. Many operators are beginning to work their trees in rough, or unburned land.

YIELD OF GUM

How much gum and naval stores will a slash pine tree yield?

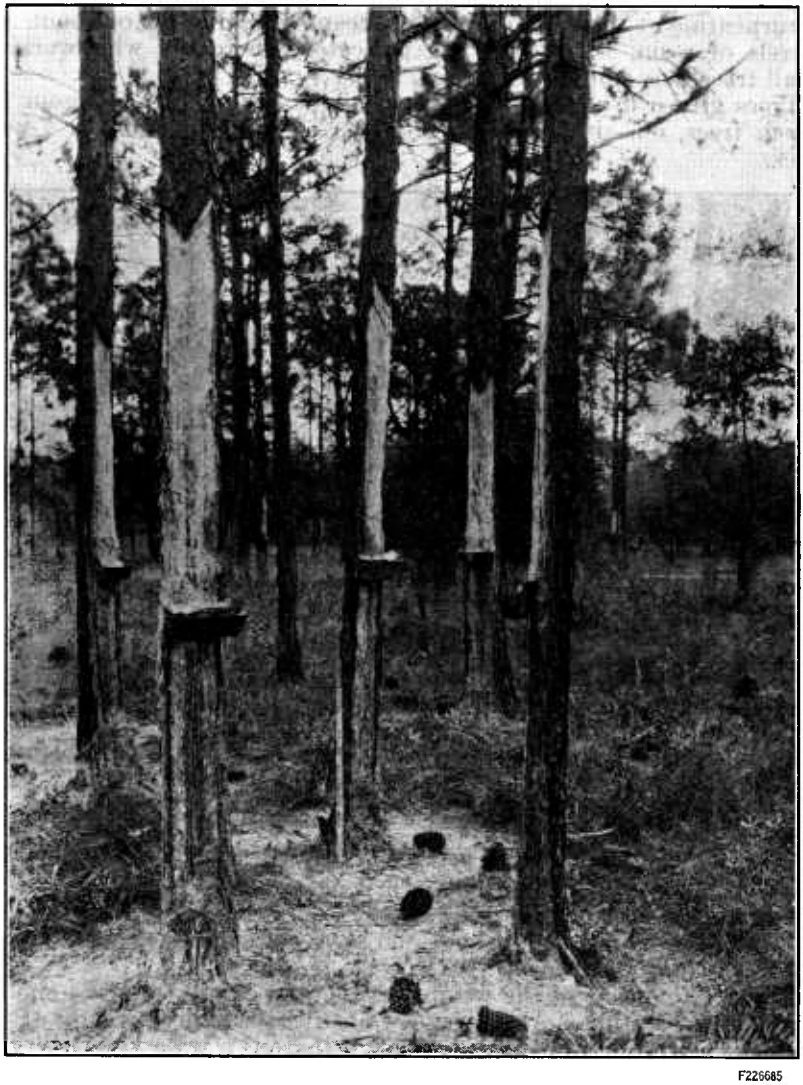
A slash pine tree, growing in an open stand worked with 32 streaks during the season and scraped, will yield as follows: If 9 inches in diameter (breast height), about 123 ounces; 10 inches, about 140 ounces; and 12 inches, about 180 ounces. Compare with these figures the yields of trees smaller than 9 inches, namely, 95 ounces from 8-inch trees and 80 ounces from 7-inch trees. In crowded or dense stands small trees run about one-quarter less for 9-inch trees and one-half less for 7-inch trees.

In units of naval stores the yield of slash pine trees may be illustrated by the average 9-inch tree, which produces a little under 8 pounds (123 ounces) of gum, which will make about one-fifth of a gallon of spirits of turpentine and about 5 pounds of rosin. A 12-inch tree will yield 11.2 pounds of gum, which will make about one-third of a gallon of spirits of turpentine and about 7 pounds of rosin.

How much naval stores will a crop of slash pine yield in a season?

There are 10,000 cups in a crop. Varying widely with conditions of size and vigor of trees, as well as the locality and the season, a crop of cups will yield in a full season from 100 to 400 barrels of gum. One dip barrel (50 gallons) of gum commonly yields from 10 to 11 gallons of spirits of turpentine; or it requires nearly 5 barrels of gum

to produce 1 barrel (50 gallons) of spirits of turpentine. The size of the tree is an important factor. A crop of average open-grown trees, worked for 5 years with 32 streaks per year, chipped one-half inch



F226685

FIGURE 15.—Bad turpentining is shown. All the trees, including those of all diameters down to 5 inches, are being worked. The faces are deep, and the aprons have been driven deep into the trees. This causes low production of gum and heavy losses of timber.

deep by one-half inch high, with one face per tree should yield about as follows for different-sized trees: A crop of 9-inch trees should produce about 42 barrels of spirits of turpentine; 10-inch trees, 49 barrels; 11-inch trees, 55 barrels; and 12-inch trees, 62 barrels. With these trees of regulation sizes, may be compared the amounts of

naval stores yielded by crops of undersized trees; namely, 8-inch trees averaging 36 barrels and 7-inch trees averaging only 31 barrels.

The amount of rosin produced at the same time is about 3⅓ barrels to 1 barrel of spirits of turpentine. For example, a 50-barrel yield of turpentine at the ratio of 1 to 3⅓ means a production of about 167 barrels of rosin. The foregoing indicates the reason why working small trees does not pay expenses.

Trees grown in dense stands yield about one-quarter less gum for 9-inch trees, one-sixth less for 12-inch, and one-third less for 7-inch trees.

F230217

FIGURE 16.—Deep chipping and the inserting of aprons often result in serious loss of timber and money returns. Such loss as this by wind and also dry facing are, fortunately, less common now than in the past.

What are some important factors about turpentining and naval stores?

A barrel or cask of spirits of turpentine contains 50 gallons. A gallon weighs about 7¼ pounds.

A barrel of rosin weighs about 500 pounds gross but contains about 420 pounds net of rosin.

About 20 percent of the weight of the gum or dip from the cups is spirits of turpentine. An average of about 9 percent by weight of the scrape is spirits of turpentine, although there is a wide variation.

The scrape from slash pine trees is relatively small in amount. It is about 6 percent by weight of the total gum yield of the tree (dip and scrape). In contrast, the scrape from longleaf pine trees, if the cups are raised each year after the first, comprises about 24 percent of their total product. Otherwise the scrape is relatively larger in amount.

About 40 pounds of dip is required to yield 1 gallon of spirits of turpentine, or about 5 barrels of dip (400 pounds of dip per barrel) to yield 1 barrel of spirits of turpentine. For each barrel of spirits there is produced on an average for the season's run about 3⅓ barrels of rosin.

Advanced streaks are of much value in producing larger yields of gum during the early chipping season. The time recommended to make advance streaks is 4 to 6 weeks ahead of the first regular streak.

Low chipping (that which removes from one-quarter to one-half inch in height by each streak) for a season or two may result in less gum, but if it is continued for the entire working life of the face it will result in a larger yield of gum than high chipping. Medium chipping of about one-half to three-quarters of an inch in depth gives the best results in slash pine (fig. 17). Deeper chipping, although for a time giving a higher gum yield, results in greater injury by dry face and by windfall.

FIGURE 17.—A stand of slash pine that is being progressively worked. The larger trees that have been worked with one face for 5 years have just been back-cupped. The small worked-out trees have been cut into pulpwood or fuel wood.

The flow of gum depends closely upon the weather. A hot spell and likewise a hot, rather dry season will increase the flow of gum.

The larger the tree the larger the total yield of gum, other conditions being practically alike. Trees measuring under 9 inches in diameter (at 4½ feet above the ground) are doubtful money makers.

The largest total production of gum from a tree is obtained by working only one face at a time, chipping low and moderately deep, and nailing instead of driving the tins. Deep driving of the tins weakens the tree, causes more windthrows, increases dry face, invites insect attack, and decreases gum yields. When two faces are worked at the same time on trees up to 12 inches in diameter the total yield is only about 70 percent as much as that obtained by working only one face at a time. Experiments indicate that not more than one face should be currently worked on any tree which is less than 14 inches in diameter.

On the national forests in Florida turpentining rights have been leased for many years to individuals or companies under the terms of a carefully drawn contract sale. This also is being started on some of the more recently created national forests in the South. Sample copies of the form used will be mailed upon application to the regional forester, United States Forest Service, Atlanta, Ga.

The Department of Agriculture has a number of publications dealing in detail with various phases of turpentining. Application should be made to the Office of Information, United States Department of Agriculture Washington, D. C.

EFFECTS OF TURPENTINING AND FIRE

Does turpentining affect the growth of a tree?

The rate of growth is greatly checked by heavy cupping. One face per tree generally checks the growth of slash pine from one-fourth to one-third of the usual rate; two or more faces, one-half or more. Following the working of the tree, a gradual recovery in rate of growth and a natural healing over of the face take place, faster in the more vigorous and healthy topped trees.

Along with the injury from wounding and attendant loss of gum, it appears certain that exposure to uncontrolled fires and the injurious agencies of rot and insect infestation subsequent to turpentining have much to do with any decline in growth that may occur. It follows that slash pine, if properly handled, may be turpentined to advantage in advance of the final working and harvesting of lumber.

Does burning affect the yield of gum?

Since the yield of gum depends much upon the vigor of the tree, full protection against heavy burning is very profitable. The burning off of the leaves or needles or straw results in reduction of gum flow until they have grown back fully (fig. 18). By killing living limbs fire causes a continuous reduction in the gum yield. Burning off most of the foliage on young timber being worked for gum is known to have reduced the yield to one-half that on adjacent unburned trees. (See also p. 46.)

TURPENTINE MANAGEMENT PLAN

In simple terms, the problem of managing a stand of slash pine has as its main object obtaining the largest amount of gum and then cutting the trees for pulpwood, lumber, or other product; pine wood is coming to have an increasing use and value for pulpwood (fig. 19).

What are the important steps in handling slash pine as a dual crop?

A stand of young slash pines may be regarded as safe from ordinary ground fires when the trees are from 10 to 20 feet in height. Such trees will be from 6 to 12 years old. At this stage the stand may be thinned out so as to save from 200 to 300 per acre of the best trees, evenly spaced.

When the trees have reached heights of 50 to 60 feet, with diameters ranging from 9 to 10 inches, turpentining operations may be begun on all the trees except about 100 of the best-developed and thriftiest trees left as evenly spaced as possible to form the final timber crop. The trees may be worked for 3 years, rested a year, and back-cupped for the next 3 years—making a work period of 7

F254975

FIGURE 18.—Fire reduces the ability of the tree to produce gum. If the tops or leaves are burned off it is advisable to rest the tree for at least 1 year. Badly burned trees may not recover for several years.

F247935

FIGURE 19.—Chipping and dipping crude gum in a stand of slash pine.

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years (fig. 20). The worked trees may then be cut and utilized for one product or another. The age of the remaining 100 trees will be from 25 to 40 years.

Slash pine trees or stands, when protected and rightly handled with rest period, can be worked for turpentine from the ages of about 15 to 40 years, or longer. A well-stocked stand will average a growth of 1 to 2 cords of wood per acre per year during the period of from 10 to 40 years, or an equivalent of 300 to 800 board feet per acre yearly.

This brings the owner to the last stage of management with an option of two courses, either of which may be adopted. The trees may all be worked as they grow, conservatively, one face at a time, for a period of 6 to 20 years. If the alternative method is adopted, the trees are allowed to grow to a good size for lumber, say 15 to 18

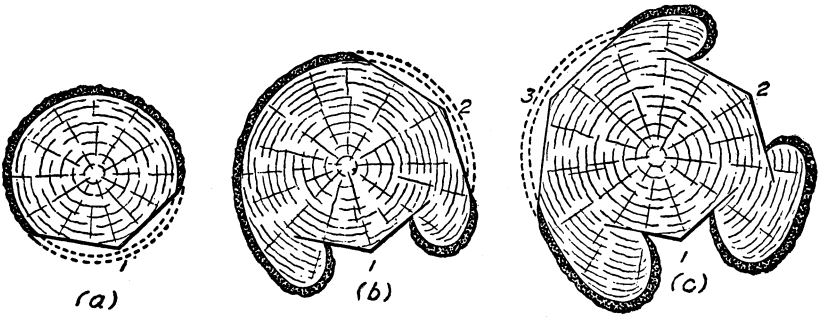


FIGURE 20.—The first working was begun when the tree (*a*) reached 10 inches in diameter (breast height). The second (*b*) was begun after a 3-year working and 3 years of rest; and the third (*c*) after similar periods of working and rest. Thus, the tree was worked 9 years during a period of 15 years. This method is one of very conservative working, resulting in a good growth of timber and high yield of gum. (The figures 1, 2, and 3 serve to identify the three faces).

inches, when they are worked heavily with two or more faces per tree for 3 or 7 years; in the latter case a year's rest is included. If the market is good, one or two high workings may be added.

The time required to grow the crop or the rotation period as here outlined will vary from 35 to 50 years, depending mostly upon the conditions of growth and market for naval stores and timber.

The exclusion of fire during the life of the stand and the one or more openings of the stand due to cutting the worked trees should result in a good restocking of the land to young pines. In the event, however, of failure to have a sufficient stand of young growth at the time for the final cutting of the mature tree crop, it would be necessary to make some special provision. One good way would be to arrange for the cutting during the late fall or winter following the scattering of a full crop of seed or mast.

LEASING TIMBER FOR TURPENTINE

The right to work trees for turpentine, often called a lease, is sold by timber owners to operators. The time is generally from 3 to 5 years, and the prices vary, depending upon the market and the size and location of the trees. Prices generally run from 3 to 5 cents per face per year, which for a 4-year lease would range from 12 to

20 cents per face. If the timber is leased on a percentage basis, the operator usually pays the timber owner from 15 to 25 percent of the local value of the turpentine and rosin produced.

Turpentine Leasing Agreement for Farmers

In leasing out turpentine rights to timber it will pay the owner well to do it under a written and signed agreement. Such a contract, in fact, will safeguard the interests of both parties. The essentials of such an agreement, as embodied in the following sample lease applicable to the use of small owners, are based upon one used by the United States Forest Service in leasing its timber on the national forests. Such money items as the rental charge per face and others which vary locally and from year to year are inserted here merely as illustrations to make the form as clear as possible.

Naval Stores Agreement

I, John Doe, of Pine City, State of Florida, hereby agree to work for naval stores certain timber on the lands owned by Richard Roe, Leesville, Fla. Said timber is all the slash and longleaf pine timber not excepted under the terms of this agreement located on an area of about 40 acres to be definitely designated by Richard Roe before cupping begins in section 9, township 4 north, range 6 east, Tallahassee meridian and base line, upon which it is estimated that 2,000 cups, more or less, may be placed. In consideration of the granting of this privilege to me for a term of 4 years I do hereby promise to pay to Richard Roe the sum of $400, more or less, as may be determined by actual count, at the rate of $200 per thousand cups, payable on or before March 15, 1939.

And I further promise and agree to work said timber in strict accordance with the following conditions:

(1) No tree will be cupped, chipped, raked, or worked in any manner until payment has been made in accordance with the terms of this agreement.

(2) Title to the product of the timber included in this agreement will remain in Richard Roe until it has been paid for as herein prescribed and removed from the tree.

(3) No timber will be cupped except that on the area designated by Richard Roe, and all timber on that area will be cupped except as herein specified.

(4) No marked tree and no tree 9 inches or less in diameter at a point 4½ feet above the ground will be cupped; not more than one cup will be placed on trees from 9 inches to 14 inches, inclusive, in diameter at breast height; not more than two cups will be placed on trees from 14 inches to 22 inches, inclusive, in diameter; and not more than three cups will be placed on any tree.

(5) The greatest depth of streaks will not exceed five-eighths of an inch at any point, excluding the bark. The width of the streaks will be so regulated that not more than three-eighths of an inch of new wood will be taken off at each chipping. The faces chipped or pulled the first season will not exceed 15 inches in height from the shoulder of the first streak of the season to the shoulder of the last streak of the season, including both. The faces chipped or pulled in subsequent seasons will not exceed 16, 15, 14, and 13 inches in height, respectively, for the second, third, fourth and fifth seasons, measured in the same way. A No. 0 hack or puller will be used for chipping or pulling. Bars or strips of bark not less than 4 inches wide in the narrowest place will be left between faces, and this width shall not be lessened as the faces progress up the tree. Where more than one face is placed on a tree, one bar between them will not exceed 8 inches in width. The first streak at the base of the face will be made at the time the apron or gutter is placed. Not more than one streak will be placed on any face during any week. Faces not chipped in accordance with these specifications may be marked out and the cups removed by Richard Roe.

(6) A cupping system satisfactory to Richard Roe will be used, and the cups and aprons or gutters will be so placed that the shoulders of the first streak will be not more than 6 inches distant from the top of the cup, and the cups first placed will be as near the ground as possible. No wood will be exposed on any tree by removing the bark below the gutter or aprons.

(7) No unnecessary damage will be done to cupped trees, marked trees, or to trees below the diameter limit. Trees that are badly damaged during the life of this agreement, when such damage is due to carelessness or negligence, shall be paid for at the rate of $6 per thousand feet board measure, full scale. Trees split or windthrown because of deep incisions for raised tins will be considered as being damaged unnecessarily.

(8) No cups will be placed later than May 15, 1939, without written permission from Richard Roe, and all timber embraced in this agreement will be cupped before said date. The cupping will proceed with all reasonable speed.

(9) Unless extension of time is granted, all timber will be chipped, dipped, and scraped, the product and all cups, aprons, gutters, and nails removed, and each cupped tree thoroughly raked to the satisfaction of Richard Roe not later than December 31, 1942. Tins will be pulled out, not chopped out.

(10) No fires will be set to the timber, underbrush, or grass on the area covered by this agreement without the written permission of Richard Roe, and during the time that this agreement remains in force I will, independently, do all in my power to prevent and suppress unauthorized forest fires on the said area and in its vicinity and will require my employees and contractors to do likewise.

(11) All cupped trees will be raked in a workmanlike manner for the space of 2½ feet around each tree during December of each year of the life of this agreement; and, if required by Richard Roe a fire line not less than 3 feet wide in the narrowest place shall be hoed or plowed around the area covered by this agreement in such a manner as to completely isolate it from adjoining lands. Natural firebreaks, such as creeks, swamps, roads, etc., may be utilized with the consent of Richard Roe. These fire lines must be made and receive the approval of Richard Roe before any cups are placed the first year or new streaks made at the beginning of each subsequent year.

(12) Richard Roe reserves the right to sell or otherwise dispose of and remove or have removed all dead timber and uncupped living timber from the area covered by, and during the life of, this agreement; provided, that the removal of such material will not interfere with the operations of the purchaser.

This agreement will not be assigned in whole or in part without the written approval of Richard Roe.

The conditions of the sale are completely set forth in this agreement, and none of its terms can be varied or modified except in writing with the approval of both parties.

And as a further guarantee of a faithful performance of the conditions of this agreement, I deliver herewith a bond in the sum of $500, and do further agree that all moneys paid under this agreement will, upon failure on my part to fulfill all and singular the conditions and requirements herein set forth, or made a part hereof, be retained by Richard Roe to be applied as far as may be to the satisfaction of my obligations assumed hereunder.

Signed in duplicate this 20th day of November 1938.

JOHN DOE,
(Signature of purchaser.)
Operator.
(Title.)

Witnesses (corporate seal, if corporation).
JOHN JONES.
TOM BROWN.

SCALING LOGS AND ESTIMATING TREES

What is a log scale rule?

A scale or rule which shows how many board feet can be cut from logs of various sizes. Most commonly, the diameter of the log in inches is measured inside the bark at the small end, and the length in feet over all.

Does it make any difference what log rule is used for measuring and selling logs?

Yes; a great difference both in the amount of timber and in the resulting money return.

The Doyle rule, although in common use in the South, is unfair to the seller for logs below about 28 inches in diameter. In the early days of large and cheap virgin timber, when narrow and knotty boards were worthless, it was fairly satisfactory, but for scaling small-sized timber, such as second-growth southern pine, it gives such small volumes for small logs as to make it unsatisfactory. On the national forests the Scribner rule (in the decimal C form) is standard. It is more fair than the Doyle rule for small logs, but reasonably careful sawing should result in obtaining from 10 to 20 percent more lumber than even this rule gives for second-growth timber.

TABLE 2.—*The contents of logs, in board feet, scaled by the International log rule, (using saw cutting ¼-inch kerf)*

Diameter at top end of log, inside bark (inches)	Contents (in board feet) of logs having a length of—						
	8 feet	10 feet	12 feet	14 feet	16 feet	18 feet	20 feet
6	10	10	15	15	20	25	25
7	10	15	20	25	30	35	40
8	15	20	25	35	40	45	50
9	20	30	35	45	50	60	70
10	30	35	45	55	65	75	85
11	35	45	55	70	80	95	105
12	45	55	70	85	95	110	125
13	55	70	85	100	115	135	150
14	65	80	100	115	135	155	175
15	75	95	115	135	155	180	205
16	85	110	130	155	180	205	235
17	95	125	150	175	205	235	265
18	110	140	170	200	230	265	300
19	125	135	190	225	260	295	335
20	135	175	210	250	290	330	370
21	150	195	235	280	320	365	410
22	170	215	260	305	355	405	455
23	185	235	285	335	390	440	495
24	205	255	310	370	425	485	540
25	220	280	340	400	460	525	590

For small timber, such as second-growth pine, the International log rule (table 2) gives log volumes which are very close to what can be sawed out by using good methods. Careless sawing will give a lower volume of square-edged boards than the logs scaled by this rule, so that it gives the millman a chance to test his own efficiency in this respect. Producers of small logs will benefit when this or some equally close rule has come into general use. The sale of logs by the International rule is recommended.

As a comparison, a log measuring 10 inches in diameter inside the bark at the small end and 16 feet long, when carefully sawed with a circular saw of ordinary thickness (¼-inch kerf) should, according to the International rule, turn out 65 board feet. For the same log the Doyle rule (table 3) would show 36 board feet, or only about one-half the amount that can be actually sawed and that is credited to it by the International rule.

TABLE 3.—*Contents of logs scaled by the Doyle log rule*

Diameter at top end of log inside bark (inches)	Contents of logs having a length of—						
	8 feet	10 feet	12 feet	14 feet	16 feet	18 feet	20 feet
	Bd. ft.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
6	2	2	3	3	4	4	5
7	4	5	7	8	9	10	11
8	8	10	12	14	16	18	20
9	12	16	19	22	25	28	31
10	18	22	27	31	36	40	45
11	24	31	37	43	49	55	61
12	32	40	48	56	64	72	80
13	40	51	61	71	81	91	101
14	50	62	75	87	100	112	125
15	60	76	91	106	121	136	151
16	72	90	108	126	144	162	180
17	84	106	127	148	169	190	211
18	98	122	147	171	196	220	245
19	112	141	169	197	225	253	281
20	128	160	192	224	256	288	320
21	144	181	217	253	289	325	361
22	162	202	243	283	324	364	405
23	180	226	271	316	361	406	451
24	200	250	300	350	400	450	500

How are logs scaled?

The diameter of the small end of the log inside the bark is measured in inches, and its length is taken in feet. If a scale stick is used, the contents of the log are read directly from the stick. These readings are for straight and sound logs. Thus the scaling of sound and straight logs is a simple matter. Experience and special knowledge are required to determine the allowance that should be made for defective logs. Slash pine logs average high in freedom from rot.[6]

How many board feet of saw timber can be cut from logs and slash pine trees of various sizes?

Much depends on the degree of care exercised, the kind of saw used, and the amounts taken from, and left in, the woods. The International rule (table 2) shows how many board feet of lumber can be sawed from straight and sound logs of different sizes with a circular saw cutting a ¼-inch kerf, all the usable lumber being taken. This rule shows not what is being cut by wasteful methods but what can be sawed out to meet the present conditions of good utilization. A deduction should be made for crook and defect.

To estimate the board-foot contents of a tree, the diameter in inches outside the bark (at breast height, or 4½ feet above the ground) and either the number of 16-foot logs or the total height of the tree should be ascertained. For example, as shown in table 4, the contents of a 14-inch tree having three 16-foot cuts is 129 board feet, or if the tree is 70 feet in height it contains 146.6 board feet. Or, if the total height of the tree and the breast-high diameter (outside the bark) are known, the contents can be estimated by referring to table 4, likewise based upon the International log rule. For example, a slash pine 16 inches in diameter and 70 feet in total height will cut out about 186 board feet, if each log is straight and sound.

[6] For more information regarding how to scale logs and estimate standing timber, consult Farmer's Bulletin 1210, Measuring and Marketing Farm Timber.

TABLE 4.—*Saw timber contained in slash pine trees of (1) various diameters and number of 16-foot logs in tree, and (2) various diameters and total height of tree*

Diameter of tree outside bark at breast height (inches)	Contents of trees[1] having—											
	Specified number of 16-foot logs					A total height of—						
	1	2	3	4	5	40 feet	50 feet	60 feet	70 feet	80 feet	90 feet	100 feet
	Bd. ft.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
7	18	27	42	------	------	9.05	12.67	17.20	23.53	30.77	--------	--------
8	20	34	52	------	------	14.48	20.82	28.96	38.01	47.97	--------	--------
9	23	39	63	88	------	21.72	30.77	41.63	53.40	66.97	--------	--------
10	25	44	76	106	139	27.15	41.63	55.20	69.68	88.69	104.98	123.03
11	------	51	88	125	166	--------	--------	69	88	110	131	156
12	------	57	101	146	192	--------	--------	84	107	133	159	186
13	------	62	115	170	221	--------	--------	100	127	157	187	221
14	------	70	129	187	250	--------	--------	116	147	180	216	253
15	------	76	143	211	282	--------	--------	131	167	205	246	290
16	------	83	160	234	314	--------	--------	148	186	229	274	344
17	------	------	177	261	348	--------	--------	163	205	253	304	362
18	------	------	193	287	384	--------	--------	179	226	278	333	396
19	------	------	212	315	422	--------	--------	195	246	302	362	431
20	------	------	231	345	463	--------	--------	212	266	327	391	465

[1] By the International log rule. Circular saw, ¼-inch kerf. Full scale for straight and sound logs. Make deduction for crook and defect in trees. For contents of trees using band-saw (⅛-inch kerf) add 12 percent.

How many slash pine trees will be required to make a cord of wood?

That depends on the size of the tree or trees. If one knows what fraction of a cord of wood is contained in trees of different specified sizes, then he can easily get the desired number of trees. Table 5 gives the fraction of a standard cord (a stack of wood 4 by 4 by 8 feet) which different-sized trees contain when worked up in usual sizes of 4-foot wood with the bark. For example, a tree 12 inches in diameter (at breast height) and 60 feet in total height, if of normal or average shape, when worked up into cordwood with the bark on, contains about 0.218 cord. This is slightly over one-fifth of a cord, or five trees of this size will make a little over a standard cord.

Or, figuring in another way, a 10-inch tree 50 feet in height contains about 0.12 cord; therefore, eight such trees would cut up into about a cord. Or, four 13-inch trees 60 feet in height would make a cord, since one tree contains one-fourth of a cord.

A person can thus measure the trees that should be thinned out for pulpwood or fuel wood, tally them by diameter and heights, and quickly calculate about how many cords they will make.

Various kinds of tree-scale sticks, or cruising sticks, are coming into use in measuring the diameter and the height, or the number of logs, in a tree. Some of the sticks also show for trees of different diameters and number of 16-foot cuts, the number of board feet of saw timber that can be cut out. Information as to sources of tree-scale and log-scale sticks and their use can be obtained from State forestry departments, the extension services of State colleges of agriculture, or the Forest Service, United States Department of Agriculture.

TIMBER PRODUCTION PER ACRE

Many stands of slash pine of known ages have been studied and measured to find out how much timber they will yield per acre. In this the forester deals with fully stocked stands, or those which have no blanks or spots without trees. The quantity of timber is measured

in the standing trees, either in cords, cross ties, or lumber. With the figures so obtained it is possible to predict the rate of growth and the quantity of timber there should be on an acre at different ages.

How many cords of wood will an acre of slash pine produce?

A fully stocked stand of slash pine 20 years old on poor land should cut out per acre about 20 cords of wood (with the bark on); on average land about 35 cords, and on good land about 46 cords (table 5). The average growth of fully stocked stands is thus from 1 to 2 cords per acre per year of wood such as is often wanted for paper pulp and fuel wood. It will be seen in table 6 that an acre of average land will produce slightly more than a cord a year in stands between the ages of 15 and 50 years; also the highest average rate of production of cordwood comes very early when the trees are not older than 15 years. Most stands are not fully stocked and produce less per acre.

TABLE 5.—*Cordwood (pulpwood, fuel wood, etc.) contained in slash pine trees of various sizes*

Diameter of tree, outside bark, at breast height (inches)	Standard cords in trees [1] having a total height of—							
	30 feet	40 feet	50 feet	60 feet	70 feet	80 feet	90 feet	100 feet
	Cord	*Cord*	*Cord*	*Cord*	*Cord*	*Cord*	*Cord*	*Cord*
5	0.018	0.027	0.037	0.047	------	------	------	------
6	.025	.036	.049	.064	0.079	------	------	------
7	.032	.048	.064	.083	.103	0.120	------	------
8	.012	.060	.080	.105	.132	.151	------	------
9	------	.07	.10	.13	.16	.19	0.22	------
10	------	.09	.12	.16	.19	.23	.26	------
11	------	.11	.15	.19	.23	.27	.31	------
12	------	.12	.17	.22	.26	.31	.36	0.39
13	------	------	.20	.25	.30	.36	.41	.45
14	------	------	.23	.29	.35	.41	.49	.51
15	------	------	.26	.33	.39	.46	.52	.58
16	------	------	.29	.36	.44	.51	.58	.64
17	------	------	------	.41	.49	.57	.64	.71
18	------	------	------	.46	.54	.62	.71	.78
19	------	------	------	.49	.59	.68	.78	.86
20	------	------	------	.53	.65	.75	.85	.94

[1] Standard cord of 128 cubic feet of wood (with bark).

TABLE 6.—*Cordwood yield per acre of slash pine at different ages, in well-stocked stands, or about maximum yields* [1]

Age of trees (years)	Wood with bark			Peeled wood		
	Good land	Average land	Poor land	Good land	Average land	Poor land
	Cords	*Cords*	*Cords*	*Cords*	*Cords*	*Cords*
15	37	27	12	29	20	9
20	46	35	20	35	25	14
25	53	42	26	41	31	18
30	59	48	32	47	37	23
35	66	54	36	53	42	27
40	72	58	40	58	45	30
45	77	62	43	62	49	32
50	81	65	45	66	51	34
55	84	67	47	68	54	36
60	86	69	48	71	56	37

[1] Includes the wood from all trees 4 inches and over in diameter.

The number of trees at any given age required to cut a cord can be easily calculated from the last column of table 1. For example, at 20 years of age on average land, fully stocked slash stands contain

about 150 trees per acre. If the stand on average land at that age cuts about 35 cords (column 3 of table 6), the average tree will cut out about one-fifth of a cord, or it will require about 5 trees to make a cord

How much saw timber will an acre of slash pine produce?

The owner or the prospective buyer of timberland should know its capacity for producing timber. Fortunately, the amount of slash pine timber that can be grown per acre can be predicted because of studies which have been made of many well-stocked, well-set, or dense stands. Table 7 shows the amount of saw timber that stands may be expected to cut at various designated ages. The figures do not include the timber removed in previous thinnings, or the intermediate yield, often a very considerable amount. It is regretted that the rate of timber production for unburned stands is not known, as it would be somewhat larger.

An acre of average-grade land well set in slash pines—for example, 30 years old as shown in table 7, column 3—should cut out an average of 11,800 board feet if all the trees measuring 7 inches and over are carefully sawed. This, in round figures, is an average growth of 400 feet a year. If the logs were scaled by the Doyle rule and only the trees that measure 9 inches and over in diameter at breast height were counted, the timber on the acre would scale only about 1,500 board feet. But the scale shown by the Doyle log rule is too low, and the cut would actually be more.

TABLE 7.—*Saw-timber yield per acre from full stocked slash pine stands at different ages*

Age of trees (years)	Actual cut by careful sawing [1] (mill tally)			Logs scaled by the Doyle rule [2]		
	On good land	On average land	On poor land	On good land	On average land	On poor land
	Bd. ft.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
15	4,900	1,400	------	------	------	------
20	9,500	3,600	450	1,000	------	------
25	15,800	7,200	1,800	3,500	------	------
30	21,700	11,800	3,600	7,000	1,500	------
35	26,700	15,800	5,400	11,000	3,500	------
40	31,200	19,900	7,700	14,500	6,000	500
45	34,800	23,100	10,000	17,500	8,000	1,500
50	37,100	25,300	11,900	19,500	10,000	2,000
55	39,400	27,600	13,100	21,500	11,500	3,000
60	41,200	29,000	14,500	23,000	12,500	3,500

[1] All trees 7 inches d. b. h. and over, per acre, International rule, ¼-inch saw kerf.
[2] All trees 9 inches d. b. h. and over, per acre, Doyle log rule.

Slash pine, when grown in well-set or dense stands and protected from fire, should grow on the lower grades of land, or situations, 1 cord a year per acre, or from 300 to 500 board feet. Such well-set and protected stands on average to good-grade lands should produce up to 2 cords an acre a year, or from 500 to 800 board feet. Such stands of natural origin are not common. Planted slash pine stands under protection and management quite commonly are producing timber at these rates.

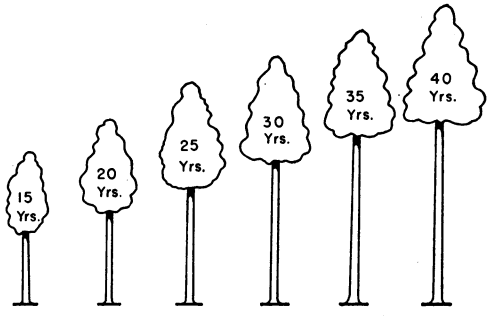
At 40 years a fully stocked acre of slash pine (table 7) on good land should cut about 31,200 board feet, an average of 780 board feet a year; on average land 19,900 board feet, or an average growth of

about 500 board feet a year; and on poor land about 7,700 feet, or an average yearly growth of 192 board feet (fig. 21). These illustrate well the wide differences in growth due to different conditions of soil, soil moisture, and climate. Conditions often vary widely in the same locality.

A caution here is advisable. These figures show what would be the yield if all the trees were sound and straight. A slight allowance for seen and unseen defects in the logs is necessary, or the scale will be somewhat too high.

What are some examples of stands actually measured?

The following essential facts concerning a few of the stands actually measured will serve as an illustration of what yields per acre may be



AVERAGE						
HEIGHT OF TREE (feet)	39	48	56	63	69	79
DIAMETER, breast height (inches)	7	8	9.5	10.5	12	13
CORDWOOD PER TREE (with bark)	0.05	0.08	0.13	0.17	0.26	0.31
CORDWOOD PER ACRE (with bark)	27	35	42	48	54	58
BOARD FEET PER TREE	9	20	42	66	105	133
SAW TIMBER PER ACRE (board feet)	1,400	3,600	7,200	11,800	15,800	19,900

FIGURE 21.—Average size of slash pine trees, their contents in cords and in board feet, and the amount of cordwood or lumber per acre at various ages. (See tables 1, 4, 5, 6, and 7.)

expected from well-stocked slash pine stands, such as are locally considered to be dense stands.

(1) A 21-year-old stand, consisting of 384 trees per acre, averaging 8 inches in diameter at breast height and 56 feet in height, contained 45 cords of wood with the bark on, or 34 cords of peeled wood. If all trees measuring 10 inches and over in diameter were cut, the stand would saw out about 6,400 board feet; or if all trees 8 inches and over were taken, it would saw about 10,300 board feet. By the Doyle log rule, however, all trees measuring 8 inches and up in diameter would scale only 3,700 board feet. This was on good land, giving about maximum yield.

(2) A 25-year-old stand, with 274 trees per acre, averaging 63 feet in height and 9 inches in diameter, containing 47 cords of wood with the bark, or 37 cords of peeled wood. The trees 10 inches and over in diameter would saw out, down to small top diameters, about 10,700 board feet per acre; or about 13,500 feet would be obtained if trees 8 inches and up in diameter were taken. If the logs in the trees measuring 8 inches and over in diameter were scaled by the Doyle rule, there would be only 5,800 board feet per acre.

(3) A 26-year-old stand with 754 trees per acre would cut 64 cords of wood with the bark, or 47 cords of peeled wood. There would be a total of only 1,300 board feet if trees measuring 10 inches and up were taken; or 8,000 feet from all trees 8 inches and over in diameter, as compared with only 1,360 feet by the Doyle rule.

(4) A 30-year-old stand, with 114 trees per acre, averaging 11 inches in diameter and 69 feet high, contained 31 cords with the bark, or 25 cords of peeled wood. There would be 9,672 board feet per acre of saw timber in the trees 10 inches and over in diameter, or 10,700 board feet in the trees 8 inches and over in diameter. If scaled by the Doyle rule, the stand had only 5,700 board feet.

(5) A 51-year-old stand, which consisted of 220 trees per acre, averaging 70 feet in height and 9.4 inches in diameter, contained 57 cords of wood with the bark, or 44 cords of peeled wood. The stand would cut out 10,100 board feet from all trees 10 inches and over in diameter, or 14,600 feet from trees measuring 8 inches and over. The Doyle rule gave only 5,900 feet of saw timber.

REFORESTATION BY NATURAL METHODS

The natural restocking of slash pine lands with young growth may be expected to take place satisfactorily whenever enough seed trees are left in logging. Young slash pine rapidly takes possession of old fields, wet lands, vacant lands near towns, and places protected from fire. Such reforestation, however, is not proceeding everywhere as there has been too-heavy cutting in some places and occasional fires (fig. 22).

There are still large areas of practically idle land in the South which should be growing timber. Many owners of small tracts and some owners of large ones are, however, seeking information and are taking active steps toward getting young pine growth to come back on their lands.

Where do the seeds come from?

Seeds come from the cones, or burs, which mature and open in the fall. Each scale bears two seeds in hollows, or pockets, at its base, which may easily be seen upon examining an open bur. However, scales near the tip and base of the bur commonly do not bear fertile seed. The burs start from very small female flowers that have been fertilized by pollen from the male flowers, and they require two seasons to mature. The pines all bear male and female flowers separately, but both kinds on the same trees.

How much seed do slash pines produce?

Slash pine is a somewhat heavy seed producer. Full or heavy seed crops may be counted on at intervals of 2 to 3 years, although some seed is borne almost every year. Well-developed cones, or burs, have been observed on trees 12 years old, but in general trees growing in the open produce seed only after reaching the age of 15 to 18 years. In close stands seed production is usually limited in quantity and begins at a little later age. The seed is small and is provided with a wing by which it is easily carried on moderate winds a distance two or three times the height of the tree or occasionally much farther (fig. 2). As a result the seeds are widely dispersed.

The number of seeds in a pound varies widely but averages about 15,500, approximately 80 seeds in every 100 being fertile. There are about 215 ripe closed burs in a bushel, the average weight of which is

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FIGURE 22.—Natural regeneration of slash pine: *A*, Good stand of slash pine resulting from plenty of seed and protection from fire; *B*, Cutting for pulpwood, leaving no seed trees to restock the land.

about 34 pounds (24 to 45 pounds). A bushel of burs will yield about 1⅕ pounds, or 18,600 seeds, an average of 87 seeds per bur. In size and appearance the seed of slash pine closely resembles that of loblolly pine, with which it is likely to be confused. The wings of slash pine seed are easily removed—more easily than those of any other kind of southern pine.

Can the seed be kept in storage?

Slash pine seed retains its vitality well in storage. The best known storage is to place the seed, after thorough drying, in tight containers and keep it at as low a temperature as can be found, preferably in cold storage at a temperature of about 25° to 35° F. If cold storage is not available, the cans or jars might well be kept in a vegetable cellar or pit. The latter storage is satisfactory for seed kept over the first winter; the former should be used to keep seed for use the second spring after collecting.

When and where do the seeds germinate?

Slash pine seeds, like longleaf, mostly germinate in the fall within a month after they reach the ground. If the seed crop is heavy and the fall rains favorable, as they are every few years, full stands of young trees result. Conditions favorable for protection from fire also account for the abundance of slash pine in moist situations and its relative scarcity on dry soils. The broad margins of bodies of water, grass bogs in swamps, and flatlands likely to be water-soaked for some time are favorite situations for reproduction. Cultivation of abandoned fields disintegrates the underlying hardpan and affords moisture conditions favorable for seedbeds. Young slash pine growing on such fields is commonly termed "old-field" pine. Fires, which fortunately are becoming less common, are still destroying vast numbers of young pines of the different species.

Can slash pine be grown successively as a crop?

With a kind of tree which seeds as abundantly as does slash pine, there is very little difficulty in growing one crop after another on the same land. Two necessary requirements for establishing a young stand are an adequate supply of seed on open ground and protection against fire. Like all the pines, the best production of slash pine comes from having even-aged trees in fairly close stands.

If a stand of pine trees is cut clean, there will be little or no young growth except where the trees are cut in the fall after the ripening of a good crop of seed. Since logging usually breaks up the surface soil the ideal time to cut the final crop or stand of trees would be during the 2 or 3 weeks while the ripened burs are opening in early fall. This would be just ahead of the period of seed germination and establishment of the young tender seedlings. Reference might well be made to the subject as found on page 37.

PLANTING SLASH PINE

The absence of seed-bearing trees on or near heavily cut or burned-over timberland, or worn-out or idle farm land makes it necessary to start young forest growth by planting small trees or sowing the seed on the land. Slash pine is especially well adapted to reforesting lands by planting young seedlings. Young slash pines have taproots and stand transplanting well if ordinary care is taken, as is shown later.

Is direct seeding of land advisable?

Direct seeding is advisable only under special conditions. In wet or crawfish land in the Coastal Plain of South Carolina and Georgia, satisfactory results have been obtained by direct sowing of slash pine seed. Early November sowings have proved more success-

ful than those made in late March or early April. Sowings made with about 2 pounds of seed broadcast in 1-year rough grass, on low, poorly drained lands have given satisfactory stands; also fair stands have resulted from sowing 1 to 1½ pounds of seed, in hoed spots with 10 seeds to the spot and 1,000 spots per acre. A fairly open stand of grass acts as a protection against sun and wind in affording moisture in the air and modifying extremes of temperature. Pine seed should never be covered more than very lightly.

In seed-spotting low wet land a good method is to scatter 8 to 10 seeds on loose soil and press them in with the foot without any, or with only a slight scattering of soil over them. Owners of recently abandoned pieces of farm land can expect satisfactory results from broadcasting 1 to 2 pounds of slash pine seed in the late fall and harrowing them in like a grain crop.

However, the seed-sowing method is regarded generally as uncertain and less satisfactory than the planting of small tree seedlings. If germination is successful, the method requires considerable labor in thinning out the excess seedlings in order to secure a stand of the desired density. If a dry period follows the sowing, germination may be so delayed as to result in a loss of the seed by insects, mice, or birds. This result has been reported as prevailing in the lower parts of the States bordering the Gulf of Mexico.

Direct seeding of slash pine might well be tried on a small scale or experimentally on wet flatlands or low old fields by landowners interested in securing another crop of trees.

Is the planting of small trees a good method of reforesting land?

The planting of small trees is in general practice in the Coastal Plain—the home of slash pine. Slash pine is one of the easiest of all the pines to grow from seed and set out much like setting cabbage or tobacco plants. Successful and extensive plantations of 1-year-old seedlings have been made in the Coastal Plain from South Carolina to Louisiana. In the latter State one lumber company has more than 12,500 acres of hand-planted young slash pine forest.

HOW TO GET PINE SEEDLINGS

How can slash pine seedlings be obtained?

Small year-old seedlings can be dug up in openings or along the edges of old fields near seed trees, or grown in a nursery bed at home, or purchased at nominal cost from the State forestry departments of the various States. Nursery-grown stock on the whole has proved more satisfactory and usually cheaper than wildling seedlings, which often have poor root development. If the acreage to be planted is large, it will probably pay to establish a local nursery and grow the trees. In any case it is advisable to write to the State forester of your State forestry department, or apply to the local county agent for advice and publications on how to get a supply of seedlings, and how to plant them. Applications for seedling trees should be made to the State forester several months in advance of midwinter or early spring—the best times for planting. Your county agent is in a position to assist you in all phases of growing timber as a crop on the farm, as he is in touch with the State extension forester. There are State or United States Department of Agriculture publications on nearly every phase of reforestation available free upon request to your

State forestry agencies, or to the Office of Information, Department of Agriculture, Washington, D. C.

Where can one get slash pine seed?

Pine seed may be collected from the trees or purchased from some of the State forestry agencies or from commercial seedsmen. It is usually an advantage to plant seed grown in the locality or nearby region. Information about crops of slash pine seed will be found on pages 33 and 34.

The seeds ripen and the burs turn brown in late summer or early fall. A good time to begin collecting is when the first bur in the locality begins to open. Another good test of the right time to begin collecting is whether the burs are ripe enough to float on water immediately after picking. The collection period usually lasts from 3 to 5 weeks. Pine seed is most economically obtained from tops of trees felled in logging. The burs should be pulled off and collected in gunny sacks, buckets, or tubs, and later spread out to dry on a tight floor or on canvas or sacking in the sun. In drying weather they will open in a few days, and if stirred or shaken the seeds will fall out. Each seed has a wing, and the mass of seed should be winged by being rubbed over a screen or between the hands and then winnowed in a steady gentle breeze or in a grain fanning mill. Seed with the wings on are unsatisfactory for direct seeding or use in nursery beds.

Commercial prices of seed range mostly from $1 to $3 per pound. In good seed years, supplies of seed may be collected and cleaned at a cost of not more than $2 per pound, if logging operations are under way so that burs can be picked off the tops of trees felled in logging. If the trees have to be climbed in order to gather the burs, the cost may go up to $3 or more per pound. Often the burs can be obtained by paying collectors from $0.75 to $1.25 per bushel, depending on the abundance and ease of collecting. One year, following a tropical hurricane, burs were obtainable in abundance for 50 to 75 cents per bushel. A bushel generally yields from 1 to 1¼ pounds of good seed. Occasionally, in dry years, pine seeds do not fill out well and are of poor quality.

How can one grow pine seedlings?

Most of the various types of nursery beds are well adapted to growing slash pine. A commonly used type consists of an ordinary bed, flat or even with the paths, or slightly raised and bordered by a curbing of 1 by 4 inch boards set 2 inches in the ground, thus holding in the soil. A width of 4 feet is standard for seedbeds (fig. 23). A sandy type of soil is much better than clay soils.

The soil should be worked well in the fall and again in the spring. Acid soils are very desirable, as damping-off fungi are common and thrive in alkaline or sweet soils. On farms the beds should preferably be located near the house, so as to be easily watched and tended, and a supply of water for use during extra-dry spells is desirable, especially during seed germination and summer droughts. All large nurseries must have adequate watering systems.

In early spring seed of good quality should be broadcast evenly on well-prepared beds at the rate of a pound (about 15,500 seeds) to each 144 square feet of seedbed (4 by 36 feet). Or the seed may be

drilled in rows spaced 6 inches apart. At the rate of 60 seeds per lineal foot of drill 1 pound of seed will be enough to drill a bed 4 feet wide by 32 feet long. The goal in seeding is to produce a crop of

FIGURE 23.—Growing slash-pine seedlings in nursery beds: *A*, One-year-old trees in Georgia State nursery ready for planting. A full stand has about 40 seedlings per square foot, but losses due to insects or disease may reduce the final crop. *B*, Small farm nursery bed of yearling seedlings in northern Florida, being viewed by interested visitors.

about 40 seedlings per square foot (broadcast), or about 20 seedlings per linear foot of drill. This is equivalent to a total of 5,760 per pound of seed sown broadcast (4- by 36-foot bed), or 5,120 per pound sown in drills (4- by 32-foot bed). With less intensive care in the

nursery and seed of lower grade the amount of seed to be sown per unit of seedbed area should be relatively increased by at least one-half pound. Losses may be expected because of infertile seed, fungi, and insects.

After being sown, the seeds are pressed into the soil by a roller, plank, or spade, and then are covered very lightly with sand and a single layer of burlap (gunny sack) or by a medium layer of fine woods litter or pine straw. The material should be as free as possible of weed seed. Sand from stream banks is well suited for use in nursery beds.

How should nursery beds be protected and cared for?

The sown beds should be watched closely, carefully protected, and watered in case of hot, dry weather. The period during the germination of the seed is especially critical, when an adequate supply of water will often mean the difference between success and failure. If a burlap cover is used, it should be removed as soon as the seeds begin to germinate, as the seedlings rise in the seed shells much as do those of cucumbers and watermelons.

Birds, mice, and insects are likely to be pests. A shotgun, traps, and poison are means of fighting these enemies. The period of germination of slash seed is usually 2 weeks or less, so that expensive wire-screened frames over the seedbeds are not necessary. Shading by screens also is unnecessary in a slash pine nursery. Ants sometimes cause much damage but may be controlled by bait poisoning. Moles sometimes cause trouble and may be kept out by encircling the bed with a narrow trench filled with lime, or by sinking a strip of half-inch wire mesh to a depth of 1 foot around the bed. The damping-off fungi are likely to attack the tender stems just below the surface when the seedlings are up to 2 weeks old. Better ventilation and drying of the surface soil is helpful. Acid soils are the best for pine nurseries; therefore never apply lime as a deterrent to this class of injurious fungi.

In parts of Louisiana and Texas a leaf-eating ant often injures or kills young slash seedlings. The control consists of pouring about one-tenth of a pint of carbon disulphide down each hole or opening to the den of the ant colony. A one-quarter-inch hard-rubber hose with a funnel inserted at one end is used. All surface openings are then closed or covered with sod. A gas is formed, killing the ants. The liquid is highly explosive, necessitating great care in handling. The cost is about 3 to 5 cents per opening.

For further information on fighting any pests of the nursery, application should be made to your local State forester or to the United States Department of Agriculture, Washington, D. C.

All weeds should from the start be pulled out when small; otherwise weeding will greatly injure the small pines. Watering during hot, dry spells is very advisable. A dense stand of seedlings such as should be growing in the beds requires much soil moisture. A gentle but thorough watering at intervals is much better than a mere surface wetting every day, and requires less time.

HOW TO PLANT PINE SEEDLINGS

When is the best time to plant pine seedlings?

In December, January, and February, before the buds begin to swell, conditions are most favorable for planting slash pine seedlings.

Late fall planting may give good results if the season happens to be wet and the winter mild, but much injury may be expected during a dry fall and during a severe winter, because of hard freezing and the

FIGURE 24.—A slash pine nursery of a Louisiana lumber company: *A*, Digging, or lifting one-season-old slash pine seedlings. The soil is carefully loosened and the trees lifted without injuring the roots. *B*, The roots and stems are wrapped in wet sphagnum moss or in burlap, and the bundles are placed in crates for delivery at the planting places. In this nursery 7,000,000 slash pine seedlings are grown.

resulting upheaval of the soil. If planted in the late spring, after the new growth has started, pine seedlings are likely to make a poor growth or die during dry weather.

What are the important steps before planting pine seedlings?

One-season-old slash pine seedlings are best for planting. At the end of one growing season they should be from 8 to 10 inches in height—sometimes higher.

The seedlings should be carefully dug and lifted from the nursery bed in order to avoid as fully as possible breaking the fine rootlets (fig. 24, *A*). All underdeveloped seedlings should be thrown away as culls, since it is an expensive mistake to plant spindling or sickly small trees. The taproot, if over 8 inches long, should be pruned back with a sharp knife. It is of the utmost importance that the roots at all times be kept wet; hence the dug seedlings should at once be placed in tubs or buckets with water, or wrapped in wet moss or gunny sack (fig. 24, *B*). If not wanted at once for planting, the seedlings should be heeled in, in fresh soil, always in a cool, shaded place, and the soil never allowed to dry out. The leaves should be left freely exposed to the air but not to direct sunlight.

The desirability of breaking or preparing the soil for planting small trees depends upon the character of the soil. If the soil is sandy or open, little is gained by plowing. If the land is rough with stumps and bushes, the trees may be planted without soil preparation. If, however, the soil is dense and has an impervious layer, it is well to break it deeply and open it up well in clods. This should be done when the soil is dry, preferably in the fall, some weeks ahead of time to plant the trees. This interval enables the soil to loosen and greatly aids in stimulating early root development.

Plows for use in preparing the soil vary with the conditions. On land that has been in cultivation in recent years, a 6- or 8-inch ripper, or pointed shovel, should be used on the point of the plow stock, and on the heel should be attached a 10- or 12-inch scraper, or wings. On land that has never been broken and is dense, a one-horse or, better, a two-horse turning plow should be used in making a round trip or two furrows. Better preparation is to go one way with a middle-buster and follow with the ripper and scraper on a plow stock, as previously described.

In planting trees, what spacing is best?

Opinion varies widely as to the most desirable spacing to be used in planting slash pines. A natural loss must always be reckoned with, varying usually from 10 to 20 percent. If the trees are planted 6 feet apart in rows 6 feet apart, 1,210 will be required to plant an acre. This is about the largest number of trees that should be planted, and it should allow for thinning out many trees as the stand develops, for pulpwood or fuel wood.

A planting of 1,000 seedling trees per acre would seem to be more desirable. Setting the trees a scant 5½ feet apart in rows spaced 8 feet apart will require 1,000 trees. Or planting them about 6½ feet apart in rows 6½ feet apart will require the same number.

A spacing of 8 by 8 feet, requiring 680 seedlings, has been extensively used in commercial plantings. The practice is now to use more trees, particularly in plantings by farmers, so as to get more wood from thinnings.

In the planting in southern Georgia referred to on page 45, the trees were set 5 feet apart in furrows 10 feet apart, or 870 to the acre. The plan was to turpentine and thin out each alternate tree as soon

as possible, leaving a stand of 436 trees, spaced 10 by 10 feet apart, for future development and working. The 10-foot lanes afforded driveways for the removal of turpentine and timber.

One essential should always be kept in view; namely, when it comes to working the trees for turpentine it is desirable to have frequent lengthwise or parallel openings as driveways, say at least 10 feet wide. These can be obtained by cutting out a row occasionally as required in any of the previously mentioned spacings of plantings. Some advise leaving a 10-foot opening every third or fourth row when planting.

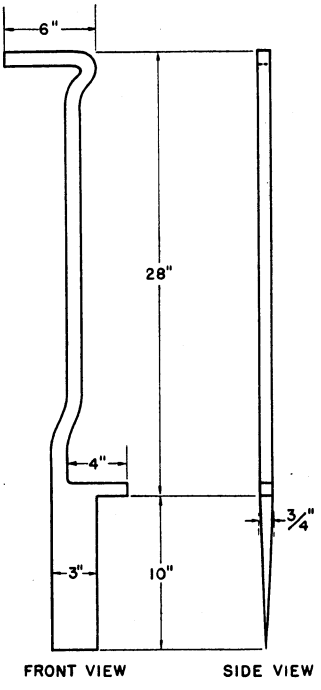

FIGURE 25.—A good kind of planting bar, or dibble, for use in the South for planting small pines. This type is being used rather extensively and with good results. The planting bar is made of two pieces of steel shaped and welded as described on this page.

What tools should be used for planting?

A mattock or a grub hoe is often used to good advantage in planting. Sometimes a spade or a shovel is employed because it is at hand, but neither is well adapted to the purpose. In most soils in the South, planting—which is done in midwinter or early spring, when the soil is moist—can best be done with the use of a planting bar, or dibble. A good planting bar, as shown in figure 25, can be made by forge-welding a heavy, carbon tool-steel blade to a shaft of steel tubing. The blade should be 3 inches wide by 10 inches long and ¾ inch thick at top, hammered to shape, ground to a tapering lower edge, and heat-treated for hardness. A foot pusher is made at the top of the blade, 4 inches in length by ¾ inch in width. The handle is of 1¼-inch (or 1½-inch) tube steel, about 28 inches long, making the tool 38 inches in length. The top of the tube is shaped to a crook and horizontal bar for use as a handle.

Various commercial tool companies make and sell planting bars. Their names and addresses can be obtained upon request from State or Federal forestry agencies.

In using the planting bar a slit is opened, the little tree is held in place by the man or boy carrying the bucket of trees, a second slit is made 3 to 5 inches from the first, and the handle moved away from the first slit so as to pinch the soil tight against the roots. The second slit is closed with the heel of the shoe.

How should pine seedlings be planted?

The essential aim of good planting is to leave the trees tightly set in the ground, at the same height that they stood in the nursery, with the least possible injury to the fine rootlets (fig. 26).

Roots must always be kept moist during planting and spread out in the hole or slit rather than bunched. Afterward the soil should be well firmed about the tree to avoid rapid drying.

One method of planting small pines is for 2 men to work together as a crew—1 making the holes and 1 carrying a bucket of trees and planting them. The bucket should have water, or better, a thin clay puddle. A 2-man crew using a mattock in average sandy soil can plant 1,000 to 1,400 trees a day or, using a dibble and having the work well organized from 1,400 to 2,000 trees. If a mattock is used, the holes are often dug larger than is necessary. They should be dug as shown in figure 27, only a little larger than necessary to spread out the roots in a natural position, with the taproot straight down. The soil is then scraped in about the tree, which should be set fully as deep as it grew in the nursery bed or woods and be well firmed with the foot (sole or heel of shoe) so as to prevent drying out. Some straw, grass, or loose soil scraped about the tree will be helpful in acting as a mulch to prevent too-rapid drying (fig. 28).

Advantage should be taken of favorable weather. Cloudy weather following rains affords ideal conditions. After planting no further attention is necessary, except protecting the trees at all times from fire and from hogs or other injurious livestock.

No livestock should be permitted to run over land set in pines for at least the first 5 years. Watering and cultivating the trees in a forest plantation are both impracticable from a financial standpoint and should not be attempted. The case is different where a few trees are set out for ornamental purposes.

In a forest plantation loss of up to 15 percent of the total number of trees set out is not an uncommon experience. Among the common causes are the poor grade of trees used, careless planting, and drought at the time of planting or soon after. If any considerable loss occurs, it is good practice to reset the blank places the next spring or a year later. The importance of fire protection is discussed on page 46.

COST OF PLANTING PER ACRE

In estimating the cost per acre of planting pine seedlings, much depends upon the size of the operation and the kind of soil and its condition. Experience shows that some farmers have found it cheaper to dig wild seedlings, while many more landowners have found it much better and cheaper in the long run to plant only thrifty nursery-grown stock because of its better root development. Such trees may be grown at home, or in most States they may be purchased from the State forestry commission.

Assuming a cost of $2.50 for a thousand nursery-grown seedlings, 680 trees per acre (spacing of 8 by 8 feet) will cost about $1.70. The cost of his mule team for an hour in furrowing an acre of land will be regarded by the average farmer as a small item. To plant 680 seedlings should take 2 men less than one-half day. The total cost, if the labor is figured at $1.50 per man per day, would amount to from $3.50 to $3.85 per acre, or about $4 if the land is furrowed. This is believed to be a conservative figure. If the spacing 6 by 6 feet is chosen (1,210 trees per acre) the corresponding cost would be about $5 per acre.

With spare hands and teams in winter the farmer may be able to reduce the cost somewhat. Probably the planting of 1,000 seedlings per acre (6½ by 6½ feet) can be done at a total cost of less than $5. Planting cut-over land on a large scale, one lumber concern in Louisi-

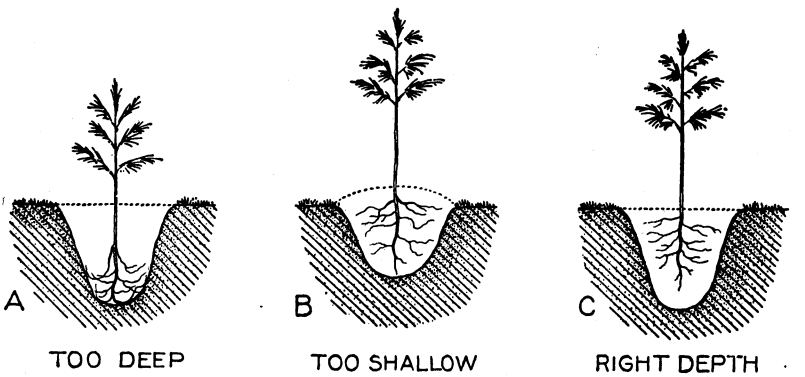

FIGURE 26.—The seedling trees should be set a little deeper than they grew in the nursery or woods as shown in *C*. Doubling up the taproot as in *A*, is extremely injurious, and if set too high, as in *B*, the tree is likely to fall over in a wind or dry out and die.

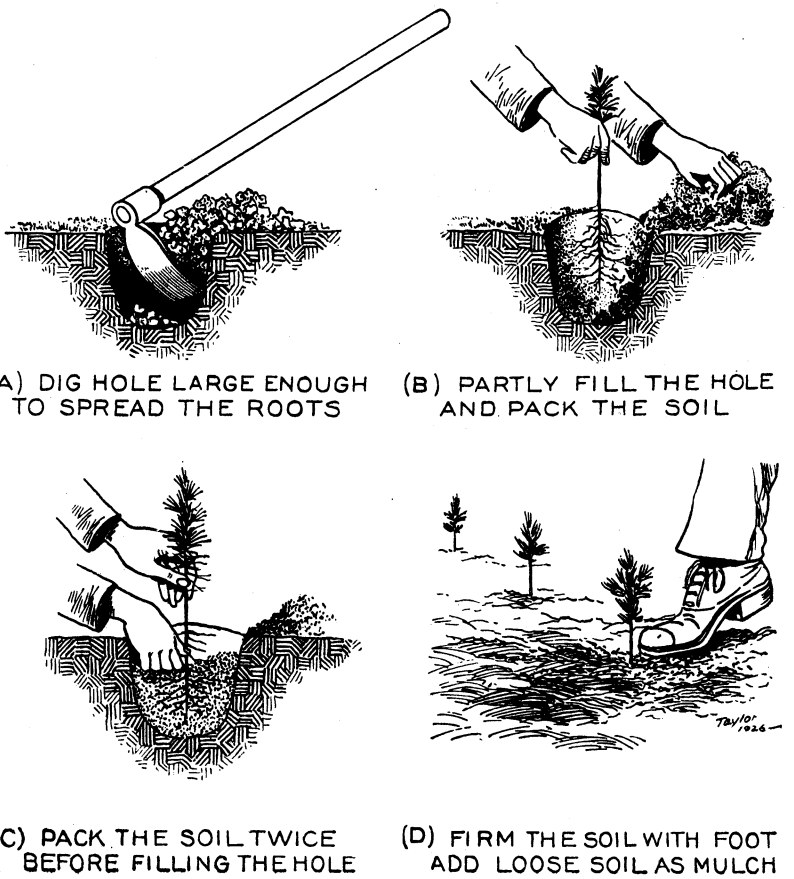

FIGURE 27.—Planting pine seedlings with a mattock or grub hoe in land that has not been treated, except possibly burned to get rid of a heavy rough. Trees may also be planted in this manner in the bottom of furrows in soil that is not loose or not easily wind-blown.

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FIGURE 28.—Methods of planting slash pines: *A*, A scooter-plow furrow followed by two ordinary furrows on the sides affords a very good planting ground, especially in heavy broomsedge fields. The competition from weeds and grass is checked and the danger from fire greatly reduced. *B*, Group of agricultural high-school boys planting poor sandy land on the school farm with slash pine seedlings. The trees were planted with mattocks or spades 6 by 6 feet apart, making a stand of 1,210 per acre—a good spacing on small tracts of land such as about farms.

ana has set out more than 16,000 acres of slash pines at an average cost of about $4 per acre, including all expense items.

Where can slash pine be planted safely?

Within its natural range slash pine may safely be planted except in deep sterile sands and very wet lands.

Small plantings or plantations of a few acres each have been made in many places in eastern North Carolina, in South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and southeastern Texas, and some in western Tennessee. Figure 29 shows a representative farmer's plantation.

It has recently been observed that a rust canker (p. 50) is affecting the small seedlings in nursery beds and larger trees in the woods. This disease is most threatening in the western part of the natural range, including Mississippi and Louisiana. Slash pine may be extended by planting, apparently with a fair degree of safety, north of its range in South Carolina, Georgia, and eastern Alabama, but elsewhere it should be planted only on a very limited or experimental scale outside its range.

Large plantations of slash pine have been established in the deep South by farmers, lumbermen, large land-holding concerns, and one or more trunk-line railroads (fig. 30). The development of a large slash pine plantation and estimated returns are illustrated and described on pages 52 and 53.

The high cost of turpentining stands of widely scattered trees points clearly to a day when turpentining can be done profitably only in stands of good density or stocking. Planted stands promise to enter in a large way into the future production of naval stores. Already, planted stands are being very profitably worked for turpentine in southern Georgia and in Florida.

PROTECTION OF THE TREE CROP

Is woods burning harmful?

The damage and loss to slash pine caused by fire is enormous and ranks along with that caused by heavy and wasteful cupping. Both these causes of injury are man-made and of all the sources of injury can be most readily controlled.

The yearly burning of the woods, still practiced in some parts of the natural home of slash pine, has been done with little realization of the enormous damage to the timber and forest land and of the money loss to the owner.

If southern pinelands have seed trees and are protected from fire, young growth will generally spring up in sufficient abundance for a new crop. Young pines that are afforded protection from fire grow rapidly and create wealth. Protection of the cut-over lands from fires (fig. 31) would mean in a relatively short time the turning of millions of acres of idle lands into profitably growing crops of turpentine and timber.

Fire protection, although very desirable throughout the life of slash pine, is particularly so during the first 3 to 5 years of the life of seedlings. The rapid growth soon takes the sapling above the hottest fire zone, which occurs just above the dense grass. In this respect slash closely resembles loblolly pine but differs widely from longleaf pine. Although trees that have attained heights of 3 to 6 feet are

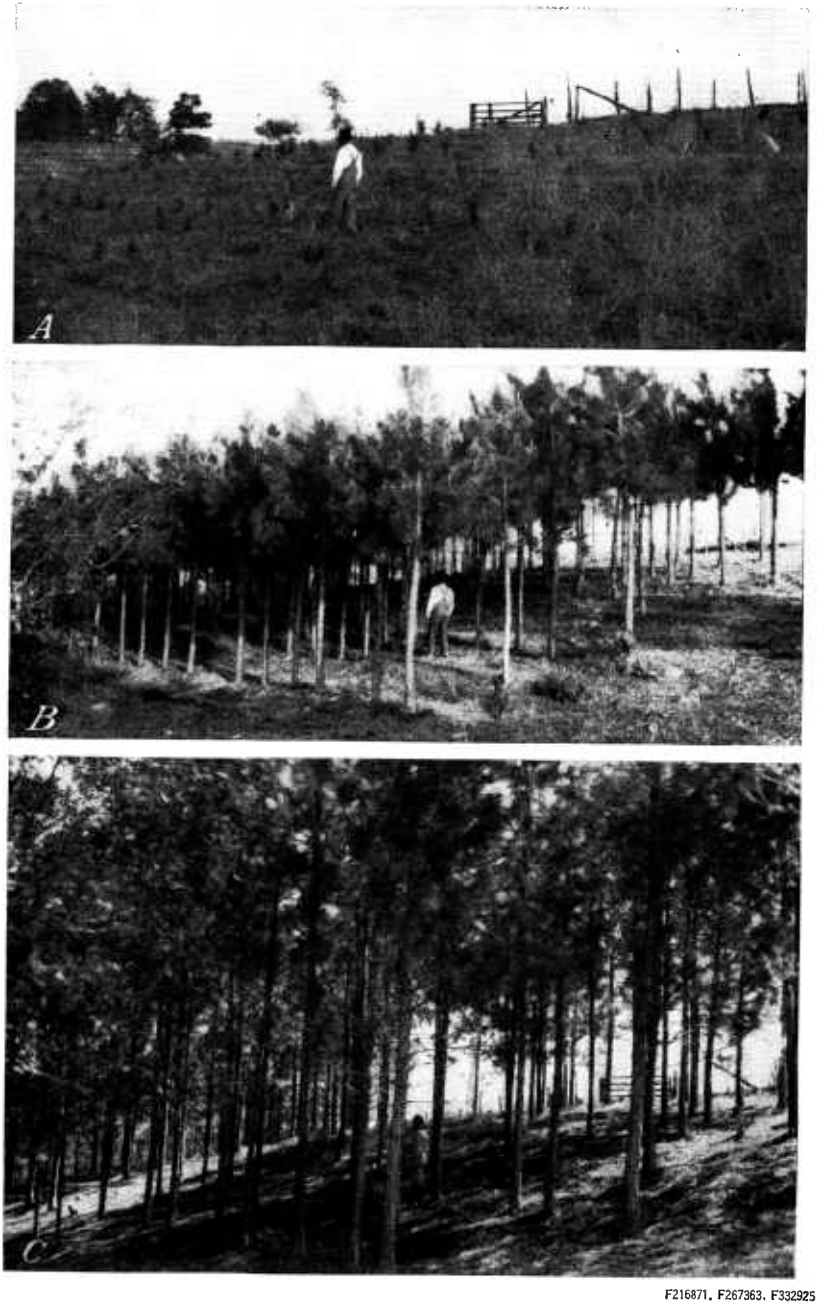

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FIGURE 29.—For 9 years this farmer hoped that pines would "take" this worn-out and idle hillside near his home in central Mississippi. Then he set slash pine seedlings, 8 by 8 feet apart, or 680 to the acre: *A*, Trees, 1 year after setting; *B*, same stand 5 years later; *C*, same stand 10 years after setting, age of trees, 12 years from seed. The farmer has cut and used fuel wood and sold pulpwood in thinning out the poorer trees.

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FIGURE 30.—Slash pine 10 years after planting in a heavy broomsedge old field in South Carolina. The trees are 35 feet in height and 6 to 8 inches in diameter. Soon the trees 9 inches or over in diameter can be worked for turpentine. A second pruning can now be profitably made in order to produce clear, high-grade timber. (Forest owned and managed by a trunk-line railway.)

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FIGURE 31.—Fire is a serious menace to young pines: *A*, A fire burning at night was stopped by this woods road which is covered with carpet grass, closely grazed. All young trees on the left were killed. Across the road is a full stand of thrifty sapling slash pines. The practice of establishing carpet grass in firebreaks for grazing as a means of better protection is increasing. *B*, Two furrows thrown together make a cheap and effective firebreak in the wire-grass country for stopping a slow fire or for use in backfiring. A disk plow and tractor are used.

injured and sometimes destroyed by slow or "cool" fires, enough trees generally remain to produce a fair stand. Stands of pine which have not passed through repeated fires are fortunately becoming more numerous.

Fire damages and weakens mature trees, making them easy prey for insects and wood-rotting fungous diseases, or so-called punks. Trees weakened by fire are easily wind-thrown, and this causes the loss of large amounts of pine timber (fig. 15). Every year millions of young pine trees, the foundation of the future forest income, are killed by fire. Other millions of young saplings are defoliated and otherwise injured, and stunted in growth. The period of growth required to reach merchantable sizes is thus lengthened and the financial returns decreased.

Pine timber grows rapidly when the trees are given enough growing space and kept from harm by fire. (See pp. 8 and 12.)

What damage is caused by insects?

Outbreaks of the southern pine beetle occur occasionally, but nearly always during years of extreme drought or locally in places where little rain has fallen for 2 or 3 months of the growing season. It is important that close watch of pine stands be kept during unusually dry periods. The adult is a small dark-brown beetle. In the soft inner bark of the tree it lays eggs which hatch into grubs, often known as worms. These feed on the rich, living layer of inner bark and new wood, thus girdling the tree and causing its death. The life history of this insect is known, and information regarding measures for checking its depredations can be obtained from State entomologists, or from the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Washington, D. C.

The pine sawyer is a large beetle whose larva, a white grub, bores into the sapwood of dead or felled timber. Its activity may be checked by peeling and drying the timber or immersing it in water.

Young slash pine seedlings are only occasionally injured by the Nantucket tip moth, which attacks the tender young shoots in the early summer. It is rare to find the shoots killed by this or any other insect. If so attacked, the tree becomes somewhat deformed, and its rate of growth is slowed up. Most trees successfully outgrow the attack.

Are pine trees subject to diseases?

If uninjured by fire or other agencies, slash pine, until an advanced age, is not seriously affected by "red heart" or other fungous diseases. Wounds caused by fire admit the spores or "seeds" of fungi, but as a rule the vigorous young trees are able to combat them successfully. Probably the antiseptic qualities of the crude gum help in this matter. After the tree reaches an advanced age red heart is likely to become an enemy, sometines eating away the heartwood and thus weakening the tree, as well as destroying the value of the affected wood. The best protection is to keep out all fires, and cut and utilize the trees as soon as they show the bumps, which are good indications of the presence of disease.

A rust canker disease [7] has been spreading over parts of the South infecting various species of pines. It causes an unnatural sprouting and deforming wounds on the stems, branches, and small trunks of

[7] *Cronartium fusiforme*, or another closely related rust canker.

trees. The other species of rust causes rounded nodules on the stems or trunks. The rust disease is showing up in some forest-nursery operations. It is threatening to become serious, and studies attempting to mitigate the disease are under way. The alternate host of the rust is known to be various species of oaks. These are being cleared off in the vicinity of large nurseries.

PROFITS FROM SLASH PINE STANDS

The financial returns from second-growth pine on the farm or small holding are not difficult to determine if fire, the chief source of damage and loss, is absent. Under fire prevention or control the

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FIGURE 32.—Slash pine ranks as the fastest-growing pine in the South up to about 20 years of age. On old fields its growth is often extremely fast. At 13 years of age this stand is being worked for turpentine with 104 trees per acre, bringing the owner $10.40 per acre. In addition there were 524 trees per acre left for future working. This stand represents about the maximum rate of growth and yield of products for the age.

lands naturally restock without expense, and the timber growth is rapid. A very favorable situation on many farms is that second-growth pine from 20 to 40 feet in height already occurs, sometimes covering a considerable part of the farm. If the timber is slash pine, it will be merchantable for turpentine, ties, pulpwood, and firewood at ages of from 20 to 30 years, yielding from 12 to 60 cords of wood per acre (fig. 32). Older stands, from 30 to 40 years of age, yield saw timber at the rate of 7,000 to 18,000 board feet per acre. Thus slash pine affords a choice of two sources of revenue. The value of young growth is being realized more and more as utilization includes smaller and smaller sizes of timber. Under these conditions, obviously, only a comparatively few years are required for rapid-growing kinds of trees to become merchantable.

LANDS RESTORED TO PRODUCTIVE USE

A large lumber company in southern Louisiana in the winter of 1924–25 planted slash pine seedlings on 1,000 acres of its cut-over land, part of about 30,000 acres that were planted. The land had been held for sale for many years, but no buyer had appeared. The planting cost was $4 per acre. The growing stand is shown in figures 33 and 34. When the trees were 12 years of age the owners cut 6 cords of pulpwood per acre, worth $1 per cord stumpage, and left 18 to 20 cords per

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FIGURE 33.—Slash pine seedlings were planted 8 by 8 feet apart, or 680 trees to an acre, on 1,000 acres of cut-over pineland in January and February 1925, by a lumber company in southern Louisiana. This picture shows the trees when 5 years old, at a height of 8 to 12 feet. (See also fig. 34.)

acre, as shown in figure 34*B*. The estimated later returns from timber up to the age of 30 years are summarized as follows:

TIMBER PRODUCTS

Original investment: Land, $3 per acre; cost of planting, $4 per acre; or a total investment of $7 per acre.

At the end of 12 years: Original investment carried at 4 percent and yearly taxes and protection at 15 cents brings the gross investment to a total of $13.45. Pulpwood sold ($6) reduces the net investment to $7.45.

End of 18 years (estimated): The net investment, carried at 4 percent, and a yearly carrying charge of 15 cents per acre, make the gross investment $10.41. Pulpwood to be sold ($6) reduces investment to $4.41 net.

At the end of 24 years (estimated): The net investment, carried at 4 percent, and yearly carrying charges of 15 cents per acre make a gross investment of $6.57. Pulpwood to be sold (6 cords at $1, or $6), and sawlogs to be sold (8,000 board feet at $5, or $40) makes a net profit of $39.43.

At the end of 30 years (estimated): Figuring the annual carrying charge of 15 cents per acre for protection against the sale of 10,000 board feet of sawlogs at $5 per thousand or $50, makes the total net profit $88.44 per acre from wood products.

TURPENTINE PRODUCTS

Working the trees for naval stores provides additional income. For this purpose it is assumed that 200 trees per acre (9 inches or over in diameter) will be worked for two 5-year periods, or 10 years, during the age period of 15 to 30 years. This will include cupping and back-cupping. At an estimated lease price of 4 cents per face per year an income of $80 will be derived.

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FIGURE 34.—Later views of the slash pine plantation, shown in figure 33: *A*, Two years later, or 7 years after planting; *B*, 6 years after the picture *A* was taken, or 13 years after planting. One year before picture *B* was taken 6 cords of pulpwood per acre were cut by taking out the least promising trees, leaving the straightest and fastest growing for later harvests of pulpwood and sawlogs. The large stumps are from the original logging of longleaf pines. Recent stumps are hidden in the grass.

TOTAL INCOME

Adding the return from turpentining to the profit from wood products gives a total of $168.44 per acre as the net income, or an average of approximately $5.60 per acre per year over the 30-year period.

TURPENTINE AND TIMBER RETURNS

Land of average quality that is well stocked with slash pine may be expected over a period of from 10 to 25 years to yield a net yearly income from crude gum of from $5 to $10 an acre. During this time, and especially following the working, the stand should yield a very considerable revenue from the sale of the timber for poles, sawlogs, pulpwood, cross ties, or fuel wood. This should materially increase the average yearly return.

Open-grown slash pine, on average situations, may be expected to produce in 40 years a merchantable log 40 feet long, measuring 10 inches at the top by 18 inches at the butt and containing 270 board feet of lumber.

Slash pine grows rapidly in dense stands and, at from 15 to 25 years of age, yields large amounts of crude turpentine. After liberal deductons for taxes and fire-protection costs during the period have been made, concrete examples of well-stocked stands of young growth show profits of from 8 to 12 percent compound interest on an investment of $5 an acre.

Crude gum, leased for working in the standing tree, has long been looked upon in the South as a standard farm product. In many sections of the South farmers are cupping their timber and selling the gum to the local stills. After trees reach 9 inches in diameter, cupping them for turpentine is extensively practiced. In closely grown slash pine stands this size corresponds to ages between 20 to 30 years on good soils and 35 to 50 years on unfavorable situations. Open-grown trees reach this size at ages of from 15 to 25 years. Many farmers and other small timber owners have derived a good profit from selling the turpentine rights to operators of stills for 4 to 6 cents per year for each face or cup for a period of 4 or 5 years' working. When carefully turpentined for a period of from 4 to 12 years or more, including resting intervals, and then turned into poles, piling, or lumber, slash pine can be handled on short rotation or at an early age with good profit.

The demand for timber to be used in making pulpwood, ties, poles, excelsior blocks, and stave wood indicates good markets hereafter for small-sized timber. New paper mills, each requiring from 100 to 500 cords of wood daily, are being established in the South in regions not already fully covered by similar mills. The pulpwood in many instances is drawn from locations 100 miles from the mill. Lumber of smaller and poorer grades is being used each year in increasing amounts, and the higher grades are relatively difficult to find and high-priced (fig. 35). These factors point toward the profitable growing of crops of slash pine with resulting benefit to the landowner, the community, and the State.

There is plenty of land on farms for growing timber as a crop after all the better lands are used for other farm crops and for pastures.

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FIGURE 35.—Slash pine in its virgin haunts. In the original forest, slash pine was confined to poorly drained flatlands, but since the cutting of the virgin forests it has spread widely over much of the region formerly dominated by longleaf pine.

No farmer can afford to pay taxes on idle land. Forest conservation on the farm has come to be a matter of economic necessity.

Forests, unlike many natural resources, can be used and regrown forever. Continuous production of tree crops on lands best suited for the purpose is the aim of forestry.

Since timber and wood are required for the successful operation of the farm and since most farmers have some lands best adapted to tree growth, the growing of timber as a crop is legitimately a part of the farm program.

FURTHER INFORMATION

The State foresters, most of whom are located at the various State capitals, and the State extension foresters of the various State colleges of agriculture are in a position to furnish further information regarding slash pine in their respective States. Farmers should consult their local agricultural county agents, who are now dealing with forest trees as a farm crop. These agents are in close touch with the State extension forester and have for distribution various publications on the subject of tree farming. Requests may also be addressed to the Office of Information, United States Department of Agriculture, Washington, D. C.

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